Better Crops WITH PLANT FOOD

May 1955 10 Cents

(*Turn to page* 31)

The Pocket Book of Agriculture

PAY DIRT

for pottery or pumpkins

In 1862, when John W. Searles, a prospector, staked mining claims on Searles Lake in California's Mojave Desert, he little knew he had discovered the richest natural deposit of *diversified* chemicals the world has ever known. In ensuing years triumphs in chemical engineering have enabled American Potash and Chemical Corporation to win from this vast dry lake bed millions of tons of basic chemicals vital to twentieth century life . . . POTASH, one of the three plant foods necessary to maintain our agricultural economy, BORAX, BORIC ACID, SODA ASH, SALT CAKE, BROMINE and LITHIUM CARBONATE used in the manufacture of glassware, ceramics, paper, enamelware and a countless array of consumer products. Constant improvement of the company's manufacturing processes at Trona, coupled with enlarged and modern research and development facilities, guarantee you a uniform and high quality source of supply.

American Potash & Chemical Corporation

TRONA
INDUSTRIAL AND AGRICULTURAL CHEMICALS

Offices • 3030 West Sixth Street, Los Angeles 54, California
• 99 Park Avenue, New York 16, New York
• 214 Walton Building, Atlanta 3, Georgia
Plants • Trona and Los Angeles, California

• BORAX • POTASH • SODA ASH • SALT CAKE • LITHIUM & BROMINE CHEMICALS
and a diversified line of specialized AGRICULTURAL, REFRIGERANT and INDUSTRIAL CHEMICALS

Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

R. H. STINCHFIELD, *Editor*

Editorial Office: 1102 16th Street, N. W., Washington 6, D. C.

VOLUME XXXIX NO. 5

TABLE OF CONTENTS, MAY 1955

A Bear-killer's Politics 3
Jeff Is a Davy Crockett Fan

The Production of Sugar Beets on Organic Soils 6
J. F. Davis Discusses Best Practices

What Is Happening to Our Citrus Soils? 11
H. D. Chapman and R. B. Harding Answer the Question and Give Evidence

Pasture Improvement Through Renovation 15
M. A. Sprague Sees Need for More of This Work

Azalea Fertilization 21
Tokuji Furuta and Charles W. Bell Describe Effects of Nutrient Deficiencies

Soil Improvement Pays in Large Figures 25
H. J. Snider Furnishes the Proof

The American Potash Institute, Inc.
1102 16th Street, N. W., Washington 6, D. C.

Member Companies: American Potash & Chemical Corporation
Duval Sulphur & Potash Company
Potash Company of America
Southwest Potash Corporation
United States Potash Company

Washington Staff

H. B. Mann, *President*
J. W. Turrentine, *President Emeritus*
J. D. Romaine, *Vice Pres. and Secy.*
R. H. Stinchfield, *Publications*
Mrs. H. N. Hudgins, *Librarian*

Branch Managers

S. D. Gray, *Washington, D. C.*
J. F. Reed, *Atlanta, Ga.*
W. L. Nelson, *Lafayette, Ind.*
M. E. McCollam, *San Jose, Calif.*
R. P. Pennington, *Hamilton, Ont.*

Caught!

Better Crops with PLANT FOOD

PUBLISHED BY THE AMERICAN POTASH INSTITUTE, INC., 1102 SIXTEENTH STREET, N.W., WASHINGTON 6, D. C., SUBSCRIPTION, $1.00 FOR 12 ISSUES; 10¢ PER COPY. COPYRIGHT, 1955, BY THE AMERICAN POTASH INSTITUTE, INC.

VOL. XXXIX WASHINGTON, D. C., MAY 1955 No. 5

We Look Back at . . .

A Bear-killer's Politics

Jeff McDermid

(ELWOOD R. MCINTYRE)

MY "bear-killer" is the hero of a popular ballad now on the juke boxes and his celebrity otherwise is kept alive by fact and fiction. What he is quoted as saying here is copied directly from his memoirs relating to his exploits in the woods and in the U. S. Congress. At one time he spoke in this fashion about a prominent national figure who was not among his favorites:

"He is an artful, speculating lawyer, who, by holding lucrative offices for more than half his lifetime, has contrived to amass a princely fortune. He is now seeking the presidency, mostly to satisfy his selfish ambition.

"He never took up arms in defense of his country in her days of darkness and peril. He never contributed a dollar of his surplus wealth to assist her in her hours of greatest want and weakness. Office and money have been the gods of his idolatry. He can lay no claim to pre-eminent services as a statesman, nor has he ever given any evidence of superior talent except as a political electioneer and intriguer. He is so totally destitute of moral courage that he never dares to give an opinion upon any important question until he finds out whether or not it will be popular.

"As a member of the U. S. Senate, he voted against the continuance of the national road and against appropriations for its repair. He voted against making donations of public lands to actual settlers. He voted against ceding the refuse lands to the new states for education and internal improvement. He voted against giving settlement and pre-emption rights to those who opened

and improved the western country. He voted against donations of public lands to Ohio to build the Miami Canal.

"But he voted in favor of erecting toll gates on the national road, thus demanding a tribute from western people for the right to travel on their own highways, built with their own money."

By this time, you will wonder and want enlightenment as to the characters in question.

The speaker was that rugged pioneer of Tennessee, Davy Crockett, and the senator aspiring to be president was later on able to get his wish for one term—Martin Van Buren.

Davy Crockett was the son of John and Rebecca Hawkins Crockett, the father an Irishman and the mother a native of Maryland. The family farmed in Pennsylvania awhile and John Crockett was a soldier in the Revolution. Later they moved to a spot near Greenville, North Carolina. Davy, the irrespressible man of action, was born August 17, 1786, somewhere along the Nolachucky river.

"MY father settled there under dangerous circumstances," writes Davy. "The country was full of troublesome Indians. By the Creeks my grandfather and grandmother were murdered at the present site of Rogersville in Hawkins county. At the same time, the Creeks wounded my uncle Joseph and took another uncle, James, a deaf-mute, as a prisoner. He remained with them for over 17 years, and he was then discovered by my father and an elder brother and purchased from the Indians at a price I do not recollect."

Soon thereafter John Crockett moved with his family and few possessions to Jefferson county, Tennessee, where he opened a tavern on a small scale for the accommodation of waggoners. Hard times were on in earnest, and the father hired out Davy to work for a teamster to go 400 miles away with a stranger. Getting homesick, Davy crept out one night and tracked backward to join a wagon train returning to his home.

Not long after reaching home again, John Crockett told his son that he owed $36 to a neighbor named Abraham Wilson. "He said that if I would go and work for the man and take up the note, he would discharge me from his service and I could go free. I contracted to work for Wilson for six months, and when my time was out I got back the note and declined to work for him any longer. I then went to work for a man named John Kennedy, a Quaker, at two shillings a day. After a week's trial, he told me he had a note on my father for $40 and that he would give it to me if I worked six months for him. I remembered that it was my father who owed it and I concluded it was my duty as a child to help him along and ease his lot as much as I could. In all this time of my engagement I never visited my home, although it was only 15 miles off.

"When I finally told my father I had paid the note for him, he shed a heap of tears, and said he was sorry he could not give me anything, but he was not able, being so poor. I had by this time (Davy was 13 years old) got mighty fond of my new rifle, and most generally carried it with me wherever I went. I would often slip out and attend the shooting matches where they shot for beef," continues Crockett.

HE had his love affairs, got jilted by one promising girl, and took up with another whom he finally married, not without some struggle to get into the good graces of his prospective mother-in-law. "We worked on together for some years renting ground and paying high rates until I found it wasn't the thing it was cracked up to be. So I concluded to quit it and cut out for some new country. At this time we had two sons, and I was better at increasing my family than my fortune." (This first wife died later and Davy remarried a widow.)

Then a few years of interlude came, when Davy joined the backwoods soldiers to round up the vicious Creek tribesmen, with General (then Colonel) Andrew Jackson as their chief Indian fighter. Crockett resided amid the deep timber 10 miles below Winchester, Tennessee. The war was set going by a bloody butchery of the whites at Fort Mimms by the Creek nation.

His first political experience came when he was asked "to offer" for the state legislature in Lawrence and Heck-

man counties. "I soon set off electioneering, which was a bran-fire new thing for me," writes Davy. "It now became necessary for me to tell the people something about the government, and an eternal sight of other things that I knowed nothing about. At about this time there was a big squirrel hunt on Duck River, which was among my people. They were to hold a barbecue and a tiptop country frolic. The dinner and the treat was to be provided by the party having taken the fewer squirrel scalps. My party was victorious. The company had everything to eat and drink that could be furnished in a new country and much fun and good humor prevailed."

Davy confesses that he had never seen a public document and he had a man to run against who could speak "prime." "He didn't think he was in any danger from an ignorant backwoods bear-hunter, but I determined to go ahead and leave it to chance what to say. I choked up as bad as if my mouth had been chockfull of mush, but the people stood listening all the while. I told them a few anecdotes amusing to them and thanked them for their attention. But I took care to remark that I was dry as powder horn, and that it was time for us all to wet our whistles a little; so I put off to the liquor stand and was followed by the greater part of the crowd."

IT was during this first campaign that Davy met Colonel Polk, later president. He was then a member of the legislature. In a large crowd, Col. Polk remarked to Crockett: "Well, Colonel Crockett, I suppose we shall have a radical change in the judiciary at the next session." In his memoirs, Crockett says that his answer was merely "Very likely." He says he "put out quick for I was afraid somebody would ask me what judiciary was, and if I knowed I wish I may be shot."

The bear-killer was elected, "doubling my competitor, with nine votes over." He states that before he had been seated long in the legislature he could have told what the judiciary was and what the government was too. After his term was over, Davy took his eldest son and a neighbor and they "cut out for the Obion, where I determined to settle." This area was an utter wilderness, full of game and Indians who were hunting, with the nearest dwelling seven miles off.

"I gathered my corn and then set out for the fall hunt. This was late in October 1822. I found bear very plenty and, indeed, all sorts of wild varmints except buffalo. I hunted on till Christmas, at which time I had lots of meat but no powder—not enough to fire Christmas guns, which is very common in our country." Thereat Crockett went to get some powder from a brother-in-law on Rutherford's Fork. He traveled through deep snow and had a close call crossing a stream. "When I got home I wasn't quite dead, but mighty nigh it; but I had my

(*Turn to page* 49)

The Production of Sugar Beets on Organic Soils

By J. F. Davis

Soil Science Department, Michigan State College, East Lansing, Michigan

SUGAR beet yields on organic soils are usually higher than those produced on most mineral soils. With improved varieties and cultural practices, the sugar content is satisfactory. Thus the total sugar per acre is as high or higher on organic soils as on mineral soils.

Sugar beet production on organic soils could be expanded materially. There are about 17,000,000 acres of organic soils in the states of Michigan, Wisconsin, Minnesota, Indiana, Ohio, and New York. In Michigan, about one acre in eight is classified as organic soil. An organic soil is defined as containing 20% or more organic matter, one foot or more in depth, and formed under conditions of poor drainage, or in a cool, moist climate.

Many factors may affect yields of sugar beets on muck or peat soils, including water level control, cultural practices, rate, grade, and placement of fertilizers, use of minor elements when needed, variety, etc. We shall attempt to summarize briefly recent data and observations regarding sugar beets, largely based upon experiments at the Michigan Muck Experimental Farm, near East Lansing, Michigan.

Water Control

Sugar beets should not be grown on poorly drained soils because of low yields and poorly shaped roots. Desirable water control includes both adequate drainage during wet periods and controlled variable water levels during the season. This applies to many crops.

An ideal situation for sugar beets is a water table of about 24 inches during the early growth period, with a lowering to 30- to 36-inch levels during the latter part of the growing season. Controlling water levels may require tile and open ditches, dams, and sometimes pumps.

Maintaining a relatively high water table in the early season acts as a frost preventive, since wet muck is less frosty than a dry surface. Excessive drainage should be avoided to assure high beet yields, and from the long-time standpoint, to slow down subsidence of the soil due to excessive unnecessary oxidation of the organic matter.

Control of Wind Erosion

If topsoil is dry and finely divided at planting time, severe damage from wind erosion may result. Keeping the surface moist by irrigation and/or high water levels, planting grain between beet rows, and the use of windbreaks aid in preventing wind damage.

Early Planting

Sugar beets should be planted as early as possible. Comparing early and late plantings, during the periods from May 6 to June 4, 1947, and May 4 to June 1, 1951, showed decreases of 2.8 and 3.9 tons of beets, or decreases of about .1 ton per day over a 4-week period. Delayed planting from May 17 to June 12, 1948, reduced the yield from 19.7 to 13.6 tons, or 6.1 tons difference, about .23 ton decrease per day of delay. The possible increases in yield from early planting may outweigh the frost and wind hazards.

TABLE I.—YIELDS OF SUGAR BEETS PER ACRE. MICHIGAN MUCK EXPERIMENTAL FARM, EAST LANSING, MICHIGAN

Fertilizer grades	Yields per acre, in tons					
	Fertilizers @ 500 lbs. per A.			Fertilizers @ 1,000 lbs. per A.		
	Av. 49–52	1953 (50B3)	1953 (216x226)	1952	1953 (50B3)	1953 (216x226)
0–10–30	14.1	23.8	16.9	19.1	24.7	23.2
0–10–20	13.7	20.7	16.4	18.4	23.4	21.8
0–10–10	10.7	15.4	12.3	14.6	21.8	21.6
0–20–10	11.3	16.0	12.6	15.9	22.1	20.4
0–0–30	5.9	11.5	4.8	8.4	14.3	11.6
0–20–0	3.2	4.8	5.9	7.6	11.8	10.0
No fert.	2.9	4.7	3.3	5.3	11.5	6.9

Fertilizer Grades

Adequate and balanced nutrition is a main factor in determining sugar beet yields. Data in Tables I and II show sugar beet yields and percentages of sucrose found in various years on differently fertilized plots. Similar annual fertilizer applications with a grain drill have been made on these same plots since 1941.

Because organic soils are naturally low in potassium, fertilizers for sugar beets should be relatively high in this nutrient. The 0-10-30 grade at 500 or 1,000 pounds per acre usually produced the highest yields and most sugar per acre. Both phosphates and potash are needed and were more effective when applied in combination than when applied singly. Potash alone gave higher yields than phosphate alone.

Wide seasonal variations in yields and sucrose content have occurred. Low yields in 1949 were in part due to late replanting following a frost on June 8. Under such adverse conditions, the 500 pounds 0-10-30 fertilizer plot produced 65% more beets than were obtained with only 10% K_2O in the fertilizer.

The percentages of sucrose in beets have varied due to seasons as well as

TABLE II.—PERCENTAGES OF SUGAR IN SUGAR BEETS

Fertilizer grades	Percentages of sucrose in sugar beets					
	Fertilizers @ 500 lbs. per A.			Fertilizers @ 1,000 lbs. per A.		
	Av. 50–52	1953 (50B3)	1953 (216x226)	1952	1953 (50B3)	1953 (216x226)
0–10–30	14.4	14.7	15.0	15.1	16.1	15.5
0–10–20	13.8	14.3	13.8	14.1	16.1	15.9
0–10–10	13.6	12.6	13.0	13.8	16.3	15.7
0–20–10	14.0	14.0	13.2	14.6	16.0	15.7
0–0–30	12.6	15.0	15.3	14.0	15.0	17.1
0–20–0	8.7	10.5	8.0	12.9	9.4	14.0
No fert.	11.9	10.9	13.4	13.8	14.8	14.4

nutritional balance. The lowest sugar content was usually found in beets from plots with phosphates but without potash.

No purity data are presented here. Marked decreases in purity occur under extreme deficiencies of phosphorus or potassium. No practical differences in per cent purity have been found when relatively adequate phosphates and potash are added.

Total Sugar per Acre

The total sugar produced per acre should be the final measure of efficiency. In Fig. 1 are graphed the tons of sucrose per acre (without considering per cent purity) as caluculated from Tables I and II. Note similar trends in sucrose yields on variously treated plots in different years. Highest sucrose yields came from 0-10-30 treatments. In 1953 the "black root" resistant variety (50 B3 or U.S. 400) gave the highest total production with the largest fertilizer application (0+100+300).

Rates per Acre

In 1952 and 1953, sugar beets were planted on two series of plots receiving 500 and 1,000 pounds of different fertilizer grades per acre annually since 1941. The plots with the double rate have consistently given higher yields of sugar beets.

These two series of plots are adjacent, but the cropping was somewhat different over the previous 13 years. Sugar beets have been grown more often on the 500-pound series. Table beets have been grown from time to time on the high-fertility series.

Black Root Disease

The incidence of damage from "black root" disease (A phanomyces) has been higher on the low-fertility series. This may be a carry-over effect from previous sugar beet crops. There seems to be less damage from "black root" on the 1,000-pound rate series, although table beets have shown some damage

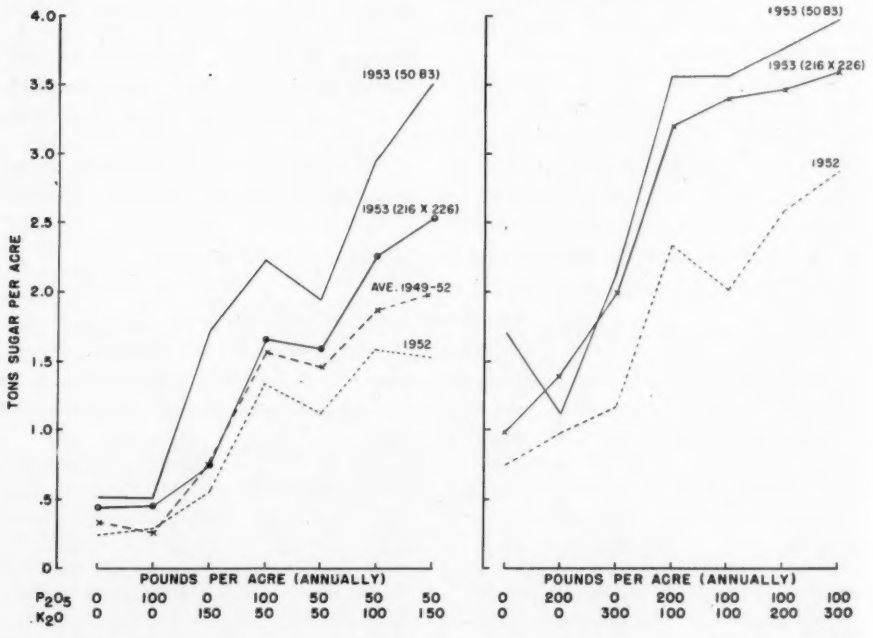


Fig. 1. The effects of fertility balance on tons of sucrose produced per acre in different years, and by two varieties.

Fig. 2. The same amount of fertilizer, 500 pounds 0-10-30, was applied on both plots. Left: drilled 3.5 inches deep with grain drill; yield 15.2 tons. Right: in band 2 inches below seed; yield 17.9 tons.

here previously.

A study of variations within each series indicates benefits from fertilizers on reducing the apparent incidence of this disease. More adequate nutrition apparently helped some plants to survive in spite of the disease. (See later discussion regarding stands, as shown in Table III.)

Varietal Differences

Two varieties of sugar beets were grown side by side across all plots in 1953. A new variety, 50 B3 (now named U.S. 400), is resistant to the "black root" disease, while the standard variety (216x226) is more susceptible. The black root resistant variety (50 B3) out-yielded the standard variety at both the low- and high-fertilization rates. (See Table I.) The differences in yields were greater in the low-fertility series. This fact was no doubt associated with the higher incidence of the disease, resulting in reduced stands on certain plots.

Note in Table III that the final stands of beets harvested per 100 feet of row were increased by certain fertilizer applications on the low-fertility series especially, where disease incidence seemed greatest. The final stands of the 50 B3 variety were larger than from the standard variety under adverse fertility conditions.

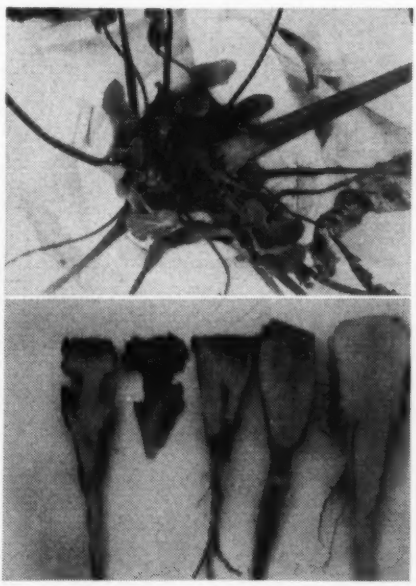


Fig. 3. Boron deficiency on sugar beets. Note the heart rot of the crown (above) and canker areas and internal deterioration of roots (below). (R. L. Cook).

TABLE III.—NUMBERS OF SUGAR BEETS HARVESTED PER 100 FEET OF ROW, AT VARIOUS FERTILITY LEVELS, AND WITH DIFFERENT VARIETIES

Fertilizer grades	Number of beets harvested per 100 feet					
	500-lb. rate series			1,000-lb. rate series		
	1952 (216x226)	1953 (50 B3)	1953 (216x216)	1952 (216x226)	1953 (50 B3)	1953 (216x216)
0–10–30	74	100	82	107	110	103
0–10–20	77	94	82	102	104	104
0–10–10	64	82	71	101	103	101
0–20–10	63	78	69	93	94	100
0–0–30	51	79	53	79	99	97
0–20–0	44	72	42	103	110	81
No fert.	33	65	47	63	115	78

Plant Spacing

About 20,000 to 23,000 plants per acre, or approximately one plant every 10 to 11 inches in 28-inch rows after blocking, is a desirable stand of sugar beets on organic soils. Close spacing results in partial weed control because shading from beet leaves discourages weed growth. During many seasons there may be considerable mortality of plants from mechanical injuries or diseases, so one must start with a full stand. However, there seems to be little significant correlation between stands and total yields until the final stand gets down below 13,000 plants per acre.

(*Turn to page* 47)

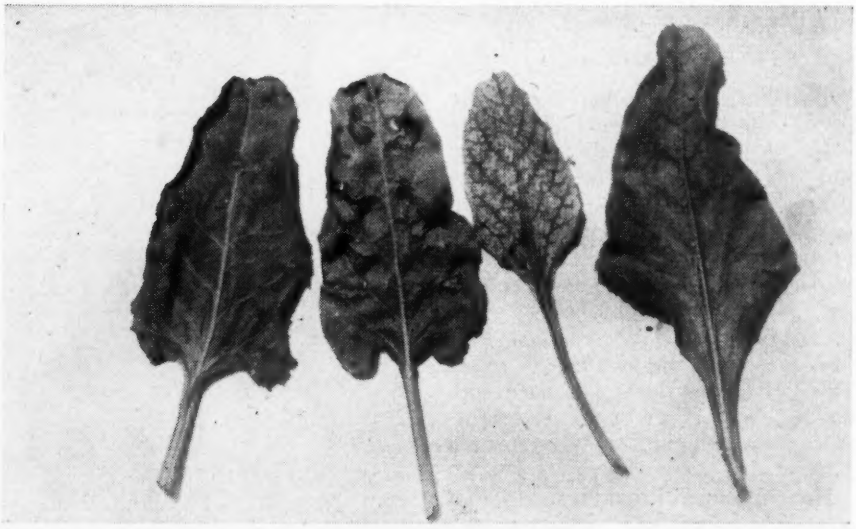


Fig. 4. A comparison of three deficiencies: Left, normal leaf. Next, magnesium deficiency, (note necrotic areas throughout the leaf.) Third from left, iron deficiency, veins very dark green with chlorotic leaf tissue. Right, manganese deficiency, veins green and less prominent than in case of iron deficiency, leaf presents a mottled appearance. (R. L. Cook.)

What Is Happening to Our Citrus Soils?

By H. D. Chapman and R. B. Harding

Department of Soils and Plant Nutrition, University of California
Citrus Experiment Station, Riverside, California

IN our preoccupation with the immediate problem of how to attain the highest possible production from soils and the development of diagnostic criteria and methods for determining nutritional status and fertilizer requirements, soil scientists have sometimes lost sight of what has always been a second great objective, namely, how to maintain soil productivity. In California we are becoming increasingly conscious of the maintenance aspect. This stems from a number of observations: (1) The slow decline of many of our older citrus orchards; (2) difficulties in replanting citrus orchards in old citrus lands; (3) decreasing permeability of water; and (4) the encroachment of urban and industrial development upon our best agricultural lands. All of these observations underscore the need to examine critically the impact of a wide range of management operations on soils. Recognizing in a somewhat more limited way than at present the importance of this problem, we began some salinity (14) and fertility trend investigations 20 years ago.

Phosphorus

In an attempt to evaluate the phosphorus status of California citrus orchards, a detailed study was undertaken some years ago. This study showed that in many of the older orchards where manure, and in many cases mixed fertilizers, had been consistently used, phosphorus had greatly increased, particularly in the upper foot of soil. The extent of phosphorus build-up in some of the more striking cases is shown by the data of Table I. A partial summary of this investigation was published by the senior author in 1934 (7).

TABLE I.—PHOSPHATE ACCUMULATIONS IN CALIFORNIA CITRUS ORCHARDS.[1]

Age orchard yrs.	Treatment	Acid soluble PO_4 ppm dry soil	
		0–6″	6–12″
23	None	370	342
	Manure	966	706
35	None	282	282
	Manure+compl.	1,680	1,680
45	None	22	24
	Manure+compl.	1,430	920

[1] From Bul. 571, Univ. Calif., 1934.

A more recent investigation (12) of the phosphate situation in a group of 45 top-producing orchards and 34 poor orchards showed that only about 20% of the 79 orchards examined had less than 500 ppm. acid soluble PO_4, whereas 80% showed more than this amount in the 0-6″ layer, thus confirming that phosphorus has accumulated markedly in many California citrus orchards.

In our lysimeter experiment where a strict account of additions and removals has been maintained, it is shown that the annual net loss to the soil where a heavy crop of Sudan grass has been harvested annually amounts to a maximum of only 16 lbs. phosphorus per

TABLE II.—PHOSPHORUS BALANCE DURING 15 YEARS OF CROPPING IN A LYSIMETER EXPERIMENT.

LBS./ACRE/15 YEARS

	Treatment		
	Straw + 200 lbs. N.	Vetch + 200 lbs. N.	Mustard + 200 lbs. N.
Added in irrig. water	1	1	1
Added in straw	38	.....	.....
Removed by crops[1]	246	244	226
Lost by leaching	1	1	1
Balance	−188	−244	−227

[1] Annual crop of Sudan grass.

acre annually. Leaching losses are almost nil. Sample data are shown in Table II. With relatively small annual crop removals and little leaching loss, it is easy to understand why most citrus orchards show marked gains; manure, both for nitrogen and organic matter, has been regarded as an indispensable component of the fertilizer program and additionally many growers in the past have applied mixed fertilizers regularly.

As a result of these studies, the present phosphorus situation in California citrus orchards appears about as follows: In a very small group of orchards where the soil was initially low in this element and where a program of straight inorganic nitrogen has been applied without manures, phosphorus deficiency has developed (2) (3) (11). We believe that less than 10% of our citrus orchards fall in this category. The remaining 90%, either because of initial ample supplies or consistent programs of manuring, have sufficient phosphate for the present and in many we are sure that excessive amounts have accumulated. Increasing evidence is at hand to indicate that these excessive accumulations of phosphate exert a detrimental effect in some soils.

It is certain that on some soils (though not necessarily all) excessive phosphate will bring on or aggravate zinc deficiency of citrus. There is also clear evidence that on some soils excessive phosphorus will decrease copper absorption and produce copper de-

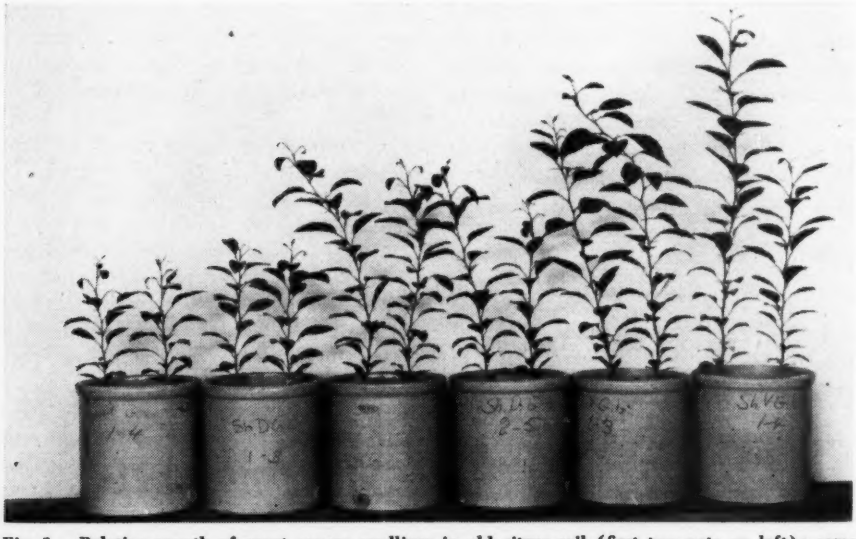


Fig. 1. Relative growth of sweet orange seedlings in old citrus soil (first two pots on left); same soil fumigated (two pots in middle); and non-citrus soil comparable to that of citrus soil (two pots on right). Details first published by James P. Martin in Soil Science, Vol. 66, pp. 273-288.

ficiency. There is also evidence that high phosphate decreases nitrogen availability in some manner and the authors believe, but have no positive proof at present, that on some soils it decreases magnesium and iron availability.

With regard to fruit quality we have evidence both in controlled cultures (9) and in field experiments (Aldrich–unpublished observations) that excessive phosphorus decreases fruit size. Increased puffiness has been noted in some years both in water cultures (9) and in field experiments, and rind breakdown due to water spot was increased one year in our high-phosphorus water cultures (9). We likewise are sure that there are important insect infestation relationships to phosphorus status of citrus, high phosphorus favoring some insects.

Fig. 2. Root growth of sweet orange seedlings grown in non-citrus soil (left) and old citrus soil (right). (From Martin, James P., Soil Science, 66:273-288.)

Potassium

Although many old citrus orchards show accumulations of potassium, it is clear from our lysimeter trial that where fertilizer containing no potash is added, this element may decrease rather rapidly. Sample data drawn from our lysimeter experiment (6) illustrate this (see Table III). Although leaching losses amount to but 1 to 2 pounds of potassium per year, and irrigation water additions range from 10 to 16 pounds annually, net losses due to crop removal amounted to from 150 to 235 pounds potash per year.

TABLE III.—POTASSIUM GAINS, LOSSES, AND BALANCE DURING 15 YEARS OF IRRIGATION AND CROPPING.

LBS./ACRE/15 YEARS

	Treatment		
	Straw + 200 lbs. N.	Vetch + 200 lbs. N.	Mustard + 200 lbs. N.
Added in irrig. water	157	248	243
Added in straw	1,077	.....	.....
Removed in crops	3,495	3,489	3,779
Lost in leaching	38	24	16
Difference	−2,299	−3,265	−3,552

Both our early and more recent surveys show that potassium has built up substantially in many orchards. In Table IV, are data to show the extent to which potassium has accumulated in some citrus orchards where manure and complete mixed fertilizers have been consistently used.

In a recent investigation of a citrus orchard suffering severely from iron chlorosis and general decline, and where heavy applications of Imperial Valley steer manure had been made annually, substantial accumulations of potassium and to a lesser extent sodium were found to have occurred. The percentage saturation of the exchange complex with

TABLE IV.—POTASSIUM ACCUMULATIONS IN CALIFORNIA CITRUS ORCHARDS.[1]

Age orchard yrs.	Treatment	Repl. +H_2O Sol. potassium	
		0–6″	6–12″
		ppm.	ppm.
40	None	86	.....
	Manure+compl.	1,023	1,023
27	None	78	89
	Manure+compl.	472	425
22	None	90	90
	Manure+compl.	617	562

[1] Unpublished data from H. D. Chapman files.

these two elements in the surface compared with subsurface horizons is shown in Table V. The alluvial sandy loam soil of this orchard is fairly uniform depthwise, and it may be safely assumed that at the outset 95% of the total exchangeable bases consisted of calcium and magnesium. Through continued manuring, Ca + Mg have now decreased to 71.3% in the surface with potassium and sodium proportionately increasing. Martin, Harding, and Murphy (22) in pot culture studies with citrus seedlings have shown that with potassium percentages in the exchange complex beyond 15%, growth reductions have occurred and that with sodium, growth reductions were quite pronounced when sodium was present

TABLE V.—PERCENTAGE SATURATION OF THE EXCHANGE COMPLEX OF A CITRUS ORCHARD SOIL HEAVILY FERTILIZED WITH MANURE.

Depth inches	Percentage saturation			Exchange capacity
	Ca + Mg	K	Mn	
0–6	71.3	22.6	6.1	9.7
6–18	83.7	11.9	4.4	7.8
18–36	90.7	2.6	6.7	9.2
36–48	95.2	1.8	3.0	7.4

to the extent of 14% in the exchange complex.

Under field conditions, Aldrich (unpublished data) has clearly shown that magnesium deficiency is produced from heavy additions of potassium fertilizers and in some trials zinc deficiency has also been greatly aggravated. Zinc and copper deficiencies are commonly very severe in old corral soils and we now believe that both the phosphate and potash accumulations in such areas are primarily responsible. We have also noted in water culture experiments with high potassium that manganese deficiency is induced.

These data illustrate that under some farming systems potassium may increase markedly, especially where heavy manuring is practiced. On the other hand, potassium may decrease rather rapidly where a crop which absorbs potash heavily is grown, where soil texture is such as to allow considerable leaching, and where fertilization does not include potassium.

Thus, under continued citrus culture, potassium deficiency is likely to develop in some soils and under some systems of management and potash excess is likely to occur in others.

With present leaf analysis techniques, combined with soil and water analyses and an appraisal of the soil characteristics and the fertilizer program, one can decide which direction potash is going. It is important for growers to appraise this situation carefully for, as stated, excessive potassium will aggravate magnesium deficiency, and may also bring on zinc deficiency and iron chlorosis, and in addition adversely affect soil permeability. Conversely, too little potash will decrease fruit sizes as shown by Chapman, Brown, and Rayner (8).

Soil Salinity

A perennial problem in irrigated soils is salinity. There is still much we do not know about various aspects of this subject, despite the con-

(*Turn to page* 40)

Fig. 1. The renovated area (left) of bromegrass-ladino clover was grazed with relish. Unrenovated area (right) contained many unpalatable weeds.

Pasture Improvement Through Renovation

By M. A. Sprague

Department of Farm Crops, Rutgers University, New Brunswick, New Jersey

FOR more than 25 years, experiments and field demonstrations throughout most of the humid regions of the United States have demonstrated the benefits of pasture renovation. Disking, reseeding, and the intelligent use of fertilizers on hilly grazing lands have on every occasion increased the yields per acre from 2 to 5 times depending upon the original condition of the sod. Returns from these pastures following renovation are nearly as great as those from plowable fields on similar soils.

The typical area for renovation in the northern humid region is predominantly a Kentucky bluegrass sod with varying percentages of weedy grasses, broadleaf herbs, and small white clover. On the more acid soils, poverty grass and sweet vernal grass are more prevalent. On the more fertile limestone soils, bluegrass and white clover assume greater dominance. There are an estimated 40 to 50 million acres of such grazing land suitable for improvement.

The abundance of poor pasture stand is witness that renovation has not been accepted for general use. This nonacceptance may be due to the necessity for too great an initial outlay, or the disking may be too laborious a task. In addition, the economic situation, with respect to available land, feed re-

quirements, purchased feeds, and prices received, may not now require these pastures as a means of keeping the farmer in business. To most field observers, however, the need is self-evident for greater pasture production for efficiency and greater profit on most livestock farms.

Much of the increase in yield from renovation can be attributed to the wise use of fertilizer on lands which have received few or no soil amendments within the history of the farm. Lime and fertilizer applications without tillage or reseeding bring an immediate yield response commensurate with the percentage of Kentucky bluegrass and white clover present. Sods with few plants of these species to serve as nuclei change their botanical composition slowly; and until clover and bluegrass become established, little increase in pasture yields or quality can be expected from topdressing alone. Trials in Pennsylvania, Rhode Island, and elsewhere in the Northeast have shown that from 1 to 4 years are required for major changes in botanical composition depending upon the original sod.

Perhaps all pastures on a few farms and some pastures on nearly all farms should be kept permanently in a well-fertilized bluegrass sod. In some farm enterprises it may not be practical to meet the more exacting grazing management required of the higher yielding species such as bromegrass and ladino clover. On occasions a smooth surface capable of withstanding heavy wear may be required. Thus, it may be the wisest practice to compromise better yields and better distribution of grazing for permanence of the sod. But such a choice of species does not forego the need for adequate fertilizer and lime to keep the perennial sod healthy and productive.

It is generally agreed that in order to get maximum returns from increased soil fertility, the best crops must be employed. Accordingly, in pasture improvement a great deal of the increase in total yield, much of the increase in quality of forage, and most of the improvement in season distribution of grazing can be attributed directly to the establishment of better adapted species.

It is unwise to attempt the establishment of higher yielding crops without first making proper soil amendments. The large investment in seed and seed-

Fig. 2. The initial step in pasture renovation is complete destruction of existing plants to reduce competition with the new seeding. Left, chemically treated; right, a live sod prior to renovation.

ing without due care for the greater nutritional requirements of higher yielding forages, such as bromegrass, ladino clover, and alfalfa, will inevitably be disappointing. Seedlings cannot be expected to survive unless supported by adequate fertility.

From 1947 to 1949 a healthy bluegrass-white clover pasture on good soil in New Jersey yielded an average of 4,130 pounds of dry matter per acre when topdressed annually with 650 pounds of 7-7-7 fertilizer. In the same three-year trial, bromegrass-ladino clover averaged 5,845 pounds and orchardgrass-ladino clover 6,007 pounds of dry forage per acre. Beyond the yield differences, it was important to observe that 64 per cent of the production of the bluegrass and bromegrass pastures was made prior to June 15; whereas only 55 per cent of the orchardgrass-ladino clover was produced before the middle of June. Accordingly, pasture improvement is to a large extent a matter of establishing better mixtures. It thereby becomes primarily a problem of seedbed preparation.

On level, easily managed soils a good seedbed can best be prepared with a plow, disk, and drag harrow. Successful seeding can then follow with conventional broadcast or band seeding equipment. Such pastures will normally be used in rotations with other crops on the farm.

Many pasture fields, however, should not, and in many cases cannot, be plowed either because they are too steep or stony or poorly drained to handle safely. In spite of these handicaps a good soil which has the capacity to produce well, is often present on these problem areas. For these pastures, renovation is advocated. It consists essentially of the replacement of aggressive, yet low yielding, plants with more productive grasses and legumes without plowing. Using this method, the steeper unplowable slopes, which constitute from 60 to 90 per cent of the pasture land on many farms, can be reseeded.

The problem of seedbed preparation on unplowable and erodible slopes has been one of the greatest single deterrents to widespread pasture improvement in the humid regions. Most farmers have been reluctant to fertilize their unproductive permanent sods without reseeding. Further, they have found

Fig. 3. Nearly as much soil has been turned with two diskings of the dead sod (left) as with 10 diskings of the live sod (right). (Same plot of ground as shown in Fig. 2.)

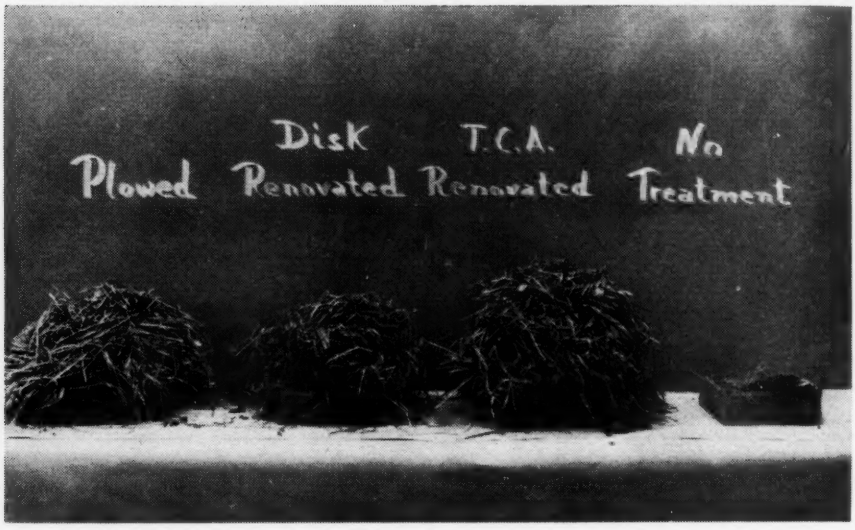


Fig. 4. Yields from 4 x 4-foot areas harvested in May from one New Jersey trial at Annandale, New Jersey.

it extremely difficult to establish new stands of the better mixtures by top seeding alone. The many seeding failures have been discouraging.

Some of the first pasture renovation trials were conducted in Wisconsin during the early 1930's. In these studies thin, weakened, grub-infested, and overgrazed bluegrass sods were burned, disked, limed, fertilized, and reseeded with drought-resistant legumes. The surface tillage left an effective mulch of turned-up sod to deter erosion while new seedlings were being established. The procedure was highly successful except in areas where competition from the old sod was not sufficiently subdued. Regrowth of unkilled grasses sometimes inhibited good seedling development.

Since these initial trials, pasture renovations have been undertaken either as experiments or demonstrations in nearly every state east of the Mississippi River. Heavy tillage implements, including oversized cutaway or smooth disks, chisel point cultivators, or weighted small farm disks, have been those most effectively employed. The heavier equipment has been a necessity on the thicker sods and larger tractors have been required to pull it. The smaller units have on many occasions been ineffective. Custom operations with the more expensive equipment have not become widespread.

Whatever the implement employed, the procedure to be most successful has been about as follows: (1) An initial break of the sod about the middle of July. (In more northern latitudes fall and early spring diskings have been employed.) (2) This is followed by frequent stirring of cut-up pieces throughout the hot, dry period of midsummer to complete the kill of unwanted species through dessication of vegetative parts. (3) The final step involves smoothing and firming operations in preparation for fertilizers and seed. This procedure when followed on schedule has given an effective kill of the old sod, a good seedbed without serious soil losses, and successful establishment.

Such heavy traffic, however, on steep rocky slopes is expensive, laborious, and dangerous. In Pennsylvania studies, such a renovation has required as much as 20 to 30 per cent more labor and power than a plowed seedbed. The

many accidents resulting from overturned tractors bear testimony that only 4-wheel or crawler type power units should be employed on most of these slopes.

Although not as effective nor as economical as plowing, the surface tillage implements under these circumstances are far better adapted to the rough and stony land. In particular, this method of seedbed preparation offers the advantages of a surface mulch and the concentration of organic matter in the upper layer of the soil as aids in maintaining soil structure in the presence of beating rains.

Because the many diskings have proved in practice to be cumbersome, hazardous, and expensive, this may be an important reason why there has not been general farmer acceptance of pasture renovation. Tillage renovations half done have resulted too often in incomplete kills of established sods and too rapid reversion to the indigenous grass climax.

Three principles are paramount in the establishment of a new stand from seed. First, undesirable plants present must be eliminated to reduce competition with the new seeding. Second, corrections must be made in the soil with intelligent use of lime and fertilizers consistent with plant needs. Third, the seed must be given soil contact and placed at the proper depth to permit emergence.

For the past five years the first requirement has been met in New Jersey trials with herbicides in place of extensive tillage. Chemical energy has thus been substituted for tractor energy to reduce a live sod to a dead mulch. Once this has been accomplished the final tillage operations for placement of seed and fertilizer are comparatively easy and few. In this way, heavy and unconventional equipment as well as much power and labor are eliminated.

In most of the experiments sodium trichloroacetate (TCA) has been used to demonstrate the principle. Other chemicals now look more promising for farm use. When used at 25 to 27 pounds per acre of active material, TCA has given acceptable kills of closely grazed bluegrass-bentgrass sods. Wherever broadleaved weeds have been present 2,4-D has been added. Where certain other grasses are present or areas have been undergrazed, more chemical has been required.

Fig. 5. Chemicals plus two diskings (left) permitted good seedling establishment. Fertility and seed (right) without seedbed preparation was little improvement over the initial sod.

In numerous farm trials 2 or 3 times over a treated field with an ordinary farm disk has been adequate to prepare a good seedbed and, in a few cases, good stands of orchardgrass and ladino clover have been obtained without disking. The sods which are dead respond far more readily to a disk than does a live sod. A light farm disk consistently rides over a live sod cutting only here and there, tearing loose elastic strips most of which quickly fall back into place. As the disk passes from unsprayed areas onto sods killed with a chemical, the implement will drop 1½ to 2 inches and each disk will turn over a clean furrow to expose the soil. The cut pieces of sod fall apart easily and crumble under a spike-tooth harrow. As a rule nearly as much soil is turned with 2 or 3 diskings of a dead sod as with 8 to 12 diskings of a live sod, and a smoother seedbed with fewer clods is the result.

Of the pastures renovated in this manner, all have compared favorably with disk renovation and plowed seedbeds. In a 10-acre trial with bromegrass and ladino clover initiated in 1952 at Annandale, New Jersey, 5,472, 5,395, and 5,969 pounds of dry forage per acre were produced during 1953 from the chemically renovated areas, disking renovation, and plowed areas repectively. These were all more than 400 per cent increases over the returns from untreated plots (1,323 pounds). During 1954 all treated plots yielded essentially the same. The stands of bromegrass and ladino clover were approximately the same on all seeded plots, but the regrowth of Kentucky bluegrass was greater on plots renovated with a disk. Considerable soil was lost from the plowed seedbed as the stand was being established, whereas there was no evidence of erosion on the other two areas protected with the surface mulch.

In comparative studies, disk-renovated plots have contained as high as 50 per cent weedy grasses four years after seeding compared with 10 to 15 per cent in adjacent plots renovated with a chemical. This regrowth has been observed wherever this comparison of seedbeds has been made. It is, therefore, reasonable to assume that renovation with chemicals will last longer. This would appear to be beneficial on hard-to-manage slopes.

(*Turn to page* 44)

Fig. 6. This disk-renovated pasture (right) with orchardgrass-ladino clover more than returned the required cash outlay the first season.

Azalea Fertilization

By Tokuji Furuta and Charles W. Bell

Department of Horticulture, Alabama Polytechnic Institute, Auburn, Alabama

AZALEAS of the Kurume type, *Rhododendron obtusum japonicum,* are used widely as a potted plant for florist sales, and as an excellent landscape plant in the warmer areas of the United States. The demand for these plants increases steadily from year to year.

Fertilizer treatments with azaleas vary widely. Despite various treatments, many symptoms suggesting nutrient deficiencies are often observed. In addition, some basis must be secured in making fertilizer recommendations for azaleas. To obtain information on these two problems, the following tests were conducted.

Procedure

Three varieties of Kurume azaleas—Coral Bells, Hexe, and Pink Pearl—were used for these tests. Two-gallon, glazed pots filled with 8-mesh silica sand were used to grow the plants. Four replications were used.

Nutrient solutions were applied to the surface of the sand and allowed to drain through three times a week on alternate days. Distilled water was applied on the remaining four days each week. The elements studied were nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, copper, manganese, boron, zinc, and molybdenum.

Check plants, which received the complete nutrient solution, had more vigorous growth and better color than most of the commercially grown plants. In general, the symptoms appeared rather slowly. By the end of the experiment, the plants that received nutrient solutions deficient in nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, or boron developed distinctive nutrient deficiency symptoms.

The following descriptions of these deficiency symptoms and the plant growth observed as a result of the differential nutrient treatments are presented in the chronological order of appearance.

Nitrogen Series

Nitrogen-deficiency symptoms were first detected about 40 days after the nutritional treatments were begun. The first noticeable symptom was that all leaves became slightly lighter green. Gradually, all leaves became a greenish yellow; the older leaves faded more rapidly to become yellow and often became red or developed reddish blotches. In some cases small necrotic areas appeared before the leaves abscised. Growth continued for a short time but at a very slow rate. The new foliage developed was greenish yellow and much smaller than on the check plants. As the deficiency continued, growth ceased, stems became brittle, leaf drop was severe, and plants were very much stunted. Flowers were few in number, small in size, and poor in quality.

Sulfur Series

Deficiency symptoms were first observed after approximately 75 days of sulfur-deficient treatment. The first symptom observed was an interveinal chlorosis of all leaves and was somewhat similar to the early stages of potassium, calcium, magnesium, and iron deficiencies. Beginning at the apex and edge of all the leaves, the green color changed to greenish yellow while the veins re-

mained green. Some leaves temporarily exhibited a mottled appearance but all leaves eventually became entirely bleached yellow or cream colored. As the deficiency continued, necrotic areas were observed on the apical edges of old leaves which had not abscised. Leaves were of medium size and the growth practically stopped after four months of treatment. Flowers were very few in number, small in size, and poor in quality.

Potassium Series

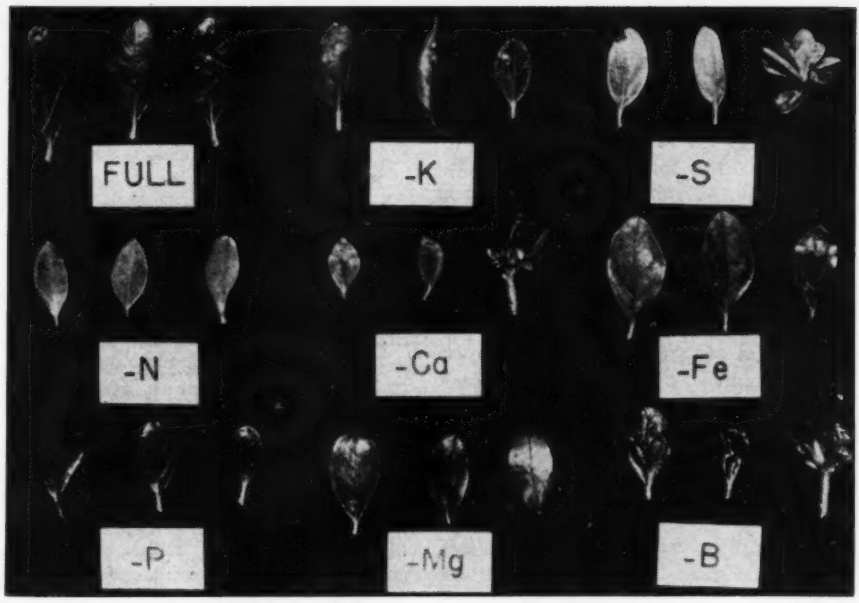
Plants that were supplied with nutrient solution deficient in potassium exhibited deficiency symptoms after about 80 days. Interveinal chlorosis of new leaves began at the apical tip and edges in much the same manner as sulfur deficiency. A temporary slight reddening was noted on both top and bottom surfaces of the apical end of the leaf. While the interveinal chlorosis symptoms continued to appear on new leaves, necrotic areas and marginal scorch appeared near the apex of recently matured leaves which became extremely bronzed. The tips of these leaves, and also of some exhibiting less severe symptoms, rolled upward. Even though leaf drop was severe, a limited amount of growth continued but the leaves were smaller than those on the check plants. As the deficiency continued, necrotic lesions became less apparent while marginal scorching increased. Foliage became increasingly chlorotic and bronzing occurred on old leaves which had not abscised. Dieback was very common and severe at this stage. Flowers were extremely few in number, small in size, and poor in quality.

Magnesium Series

Deficiency symptoms appeared after being supplied with magnesium-deficient solution for about 85 days. Interveinal chlorosis affected mature leaves located near the terminal portion of the stem. Chlorosis began at the apex and the leaf color changed from green to yellow-green or even bleached yellow accompanied by reddish-purple blotches mostly on the upper leaves of the plants. All chlorotic leaves had slightly reddened veins on the under side, and later some older leaves were bronze in color and necrotic at the tips. Leaf drop was very severe, especially with older leaves. Very few leaves remained on the stem long enough for necrotic areas to develop, and sometimes long bare stems were observed. Tips of affected leaves curled downward. Growth practically ceased after six months of treatment, and the leaves were somewhat smaller than those of the check plants. Flowers were very few in number, smaller in size, and poor in quality.

Boron Series

The earliest symptom observed was a light flecking of brown dots which appeared on the young expanding leaves after about 90 days of treatment. The first leaves affected continued to grow and develop to normal size and shape, but the flecking remained as translucent dots. New leaves thereafter contained many small necrotic spots that coalesced sometimes to form necrotic areas and margins throughout the leaf. The death of this tissue prevented normal development of the leaf and caused severe leaf distortion. As the deficiency continued, all growing points were affected to an extent that the terminal buds perished. In some cases, numerous shoots containing excessive numbers of extremely small leaves developed at the lower part of the plant. Average leaves were slightly smaller than those of check plants, but apparently the growth of plants deficient in boron was not restricted throughout the length of the experiment. Flowers were average in number and size and fair in quality. Flowers of variety Pink Pearl were orange-red whereas the normal color was light pink. Flowers of variety Coral Bells



had brown and necrotic areas on the inner face of the corolla.

Calcium Series

The symptoms that appeared as a result of calcium deficiency were noticed after calcium-deficient solution had been supplied about 120 days. Interveinal chlorosis of new leaves marked the early stages, which were followed by tip burning on some of these leaves as they were expanding. Even though this symptom did not appear on all growing points, all growing points did have pale yellow or cream-colored leaves which were smaller than those of the check plants. As the deficiency continued, new terminal leaves sometimes became twisted and the terminal buds were killed. Tip burning increased toward the base on all the older leaves which curled downward in the necrotic areas. The small bract-like leaves immediately surrounding the flower buds also developed severe tip burn. Some dieback occurred on a few of the more vigorous shoots; however, with this exception, good growth was made. Flowers were few in number, average in size, and fair in quality.

Phosphorus Series

Plants grown in a phosphorus-deficient solution exhibited deficiency symptoms after about 185 days of treatment. Leaves became dull, dark green with some slightly reddened areas along the midrib on the lower leaf surface. Growth had practically ceased at this stage of development. As the deficiency continued, small irregular reddish-purple blotches appeared on the upper surface of some of the lower leaves on the more vigorous shoots. After about eight months of treatment, these lower leaves turned a uniform dark brown and remained several weeks in a dried and shriveled form attached to the stem. Later, these lower leaves abscised and a long bare stem was left with only a tuft of mature reddish bronze leaves. Flowers were few in number, small in size, and fair in quality. Flowers of variety Pink Pearl were creamy white whereas the normal color was light pink.

Iron Series

Symptoms of iron deficiency were not apparent until after about 210 days of treatment. Interveinal chlorosis of the younger leaves was the first symptom. This new foliage remained small and yellow. Later the entire surface of these leaves became a cream color and a few leaves became white. The older leaves were not affected but the recently matured leaves became chlorotic beginning at the apical end. Plants made good growth but the appearance of the plant was very poor. Flowers were average in number and size and good in quality.

Growth of Plants

All azalea plants that were supplied with complete nutrient solution made satisfactory growth throughout the experiment. The rate of stem elongation for the three varieties was similar for each treatment. However, the total amount of growth was different because of inherent varietal characteristics for growth.

The stem elongation of all three varieties of azaleas deficient in nitrogen, phosphrus, potassium, magnesium, or sulfur was consistently less than the stem elongation of the check plants. In addition, plants of the varieties Coral Bells from the copper-deficient treatment and Hexe from the calcium-deficient and zinc-deficient treatments had less stem elongation than the check plants.

The stem diameter of all three varieties of azaleas deficient in nitrogen, phosphorus, potassium, magnesium, sulfur, or iron was smaller than the stem diameter of check plants. In addition, plants of the variety Coral Bells from the calcium-deficient treatment, variety Hexe from the manganese-deficient treatment, and varieties Coral Bells and Hexe from the zinc-deficient treatment had stems of smaller diameter than the check plants.

Plants of all three varieties deficient in nitrogen, phosphorus, potassium, magesium, or sulfur had less green weight significant at 1% level than the check plants. Plants of the variety Hexe deficient in potassium had less green weight, significant only at the 5% level, than the check plants. Plants of the variety Pink Pearl deficient in manganese had more green weight, significant at the 1% level, than the check plants.

Plants of the variety Coral Bells deficient in nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, copper, or manganese had less dry weight, significant at the 1% level, than the check plants. However, plants deficient in copper had less dry weight, significant only at the 5% level, than the check plants. Plants of the variety Hexe deficient in nitrogen, phosphorus, magnesium, or sulfur had less dry weight, significant at the 1% level, than the check plants. Plants of the variety Pink Pearl deficient in nitrogen, phosphorus, potassium, or sulfur had less dry weight, significant at the 1% level, than the check plants. However, plants deficient in manganese had more dry weight, significant at the 1% level, than the check plants.

Influence of Rates and Analyses of Fertilizers

Rooted cuttings of the varieties Coral Bells, Hexe, and Pink Pearl were grown in glazed pots in a greenhouse, using a mixture of one-fourth peat and three-fourths sand. Various fertilizer analyses were compounded at A.P.I. Agricultural Experiment Station, using acid peat as the filler. The analyses were 0-10-8, 3-10-8, 6-10-8, 6-0-8, 6-5-8, 6-15-8, 6-10-0, 6-10-4, and 6-10-12. These fertilizers were applied at rates varying from 0 to 12,000 pounds per acre per year. The yearly amount was divided into four equal applications, spaced three months apart.

Separate tests were made testing the value of additional quantities of various minor elements and the type and amounts of organic matter used in the

(*Turn to page* 48)

Soil Improvement Pays in Large Figures

By H. J. Snider

College of Agriculture, Urbana, Illinois

IT appears rather plausible that a ton of manure might have a value of $12.80 based on increased crop yields created by its use. We are willing to accept such a value without too much questioning, but incredibility begins to creep in when we arrive at $94.50 as the value for a ton of limestone based on enlarged crop yields. Some folks may be inclined to remove their glasses and stop reading when they get to the figure $72.25 as the return on a ton of finely ground rock phosphate when used on Midwest farm land. If you are still with us, the dizzy spiral continues with $339.15 as the value of a ton of muriate of potash when used on Midwest farm crops. These figures are conservative averages covering the results of eight years of cropping on three groups of Illinois experiment fields. The returns were calculated from on-the-farm

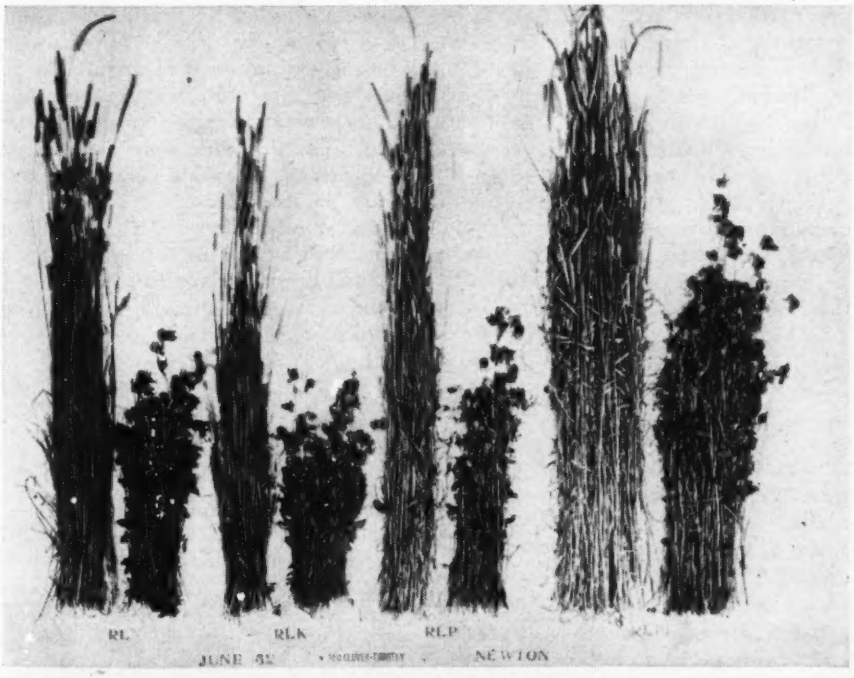


Fig. 1. This photograph shows the legume-grass mixture from four square feet areas on four different soil treatments in the residue system. The red clover and timothy were separated in order to show the growth on respective plots of the Newton experiment field. On the left is the growth from residues and limestone; next is from residues, limestone, and potash; then residues, limestone, and rock phosphate; and on the right is the growth from residues, limestone, rock phosphate, and potash.

prices and are strictly in line with current market values of corn, soybeans, oats, wheat, and hay.

There were 21 experiment fields used in obtaining these averages, and the individual fields are located at various points in Illinois. The fields were grouped by Professor L. B. Miller with relation to the soil condition and its productive levels. One group made up of seven fields represented dark-colored soils capable of producing 75 bushels of corn on untreated land. These soils are located in central and northern Illinois. Another group of five fields represented medium productive land capable of producing 50 bushels of corn on untreated land. This group is located generally in the central and northern part of the State although one field of this group is definitely in southern Illinois and another is on the borderline. Another group of eight fields is located on the lighter soils generally considered low productive farm lands capable of producing around 20 bushels of corn on untreated soils. This group is in southern Illinois. Sandy land is represented by one location in western Illinois, and results from this represent 8-year averages from only one field.

Nearly all of these fields have been in operation and under soil treatment for 40 or more years. The majority were started in the years 1910 to 1914 with three of them begun a year or so later. The plan of soil treatment or land-use plan was conceived previous to 1910. At this early date many fertilizers now in use were not then known, and some of the materials used then are not used as fertilizers today. There were no quick tests to use as guides for soil needs. The only chemical aid was total analysis which did not prove to be greatly helpful. Sole dependence was placed on soil color, condition of crops, apparent physical condition, drainage, and a few other factors. The essential thing here is the long-time effect on productivity of crop rotation, legumes, manure, limestone, phosphate, and potash. All averages are for the last eight years of approximately a 40-year period of a continuous experimental operation.

The original plan included two general types of farming—first, the livestock system, and second, the crop residue or legume system. The former involved the idea of farm manure as the basic organic material for soil improvement. The other involved the use of crop residues including legumes as the basic organic material. This general plan has been adhered to down to the present years. This by no means represents the entire soils program on experiment fields. The Illinois Experiment Station has at all times made a strong effort to keep abreast of the times and has gone seriously into all branches of soil research as new conditions developed. It has, however, retained a large portion of this original plan.

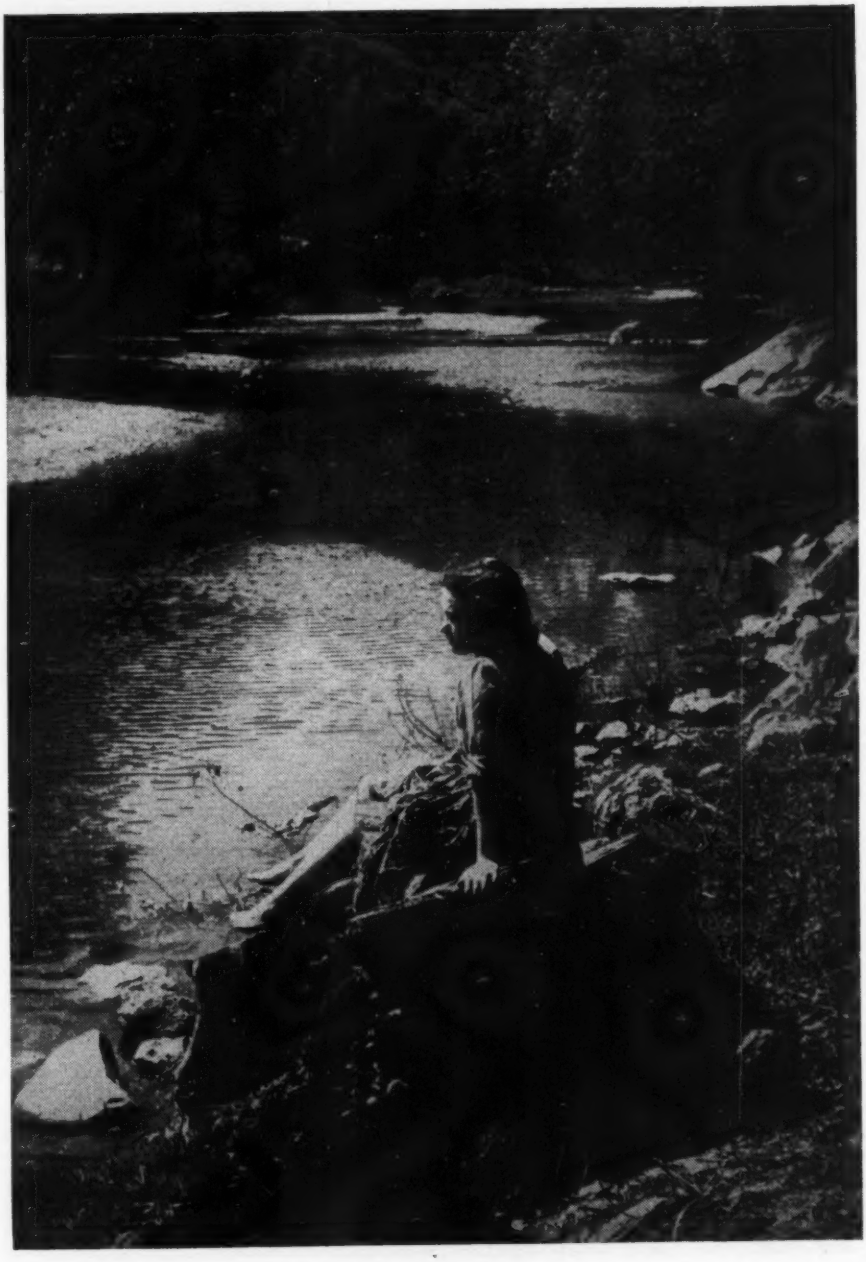
The dark-colored, high productive land represented by seven fields gave an acre value of $24.50 for manure. Since it was put on at approximately 15 tons per acre for each rotation, the value was $6.50 per ton of manure used. On the dark soils of medium productivity, the value of manure was $26.00 an acre. Here it was used at the rate of about 10 tons per acre every four years, which gave an average of $10.50 per ton of manure applied.

For an average of eight fields located on low productive land, manure had a value of $16.00 an acre and $12.80 per ton of manure used. On this land the rotation rate was five tons an acre put on ahead of the corn crop. On the sandy land the value of manure was $12.00 an acre and $12.00 per ton.

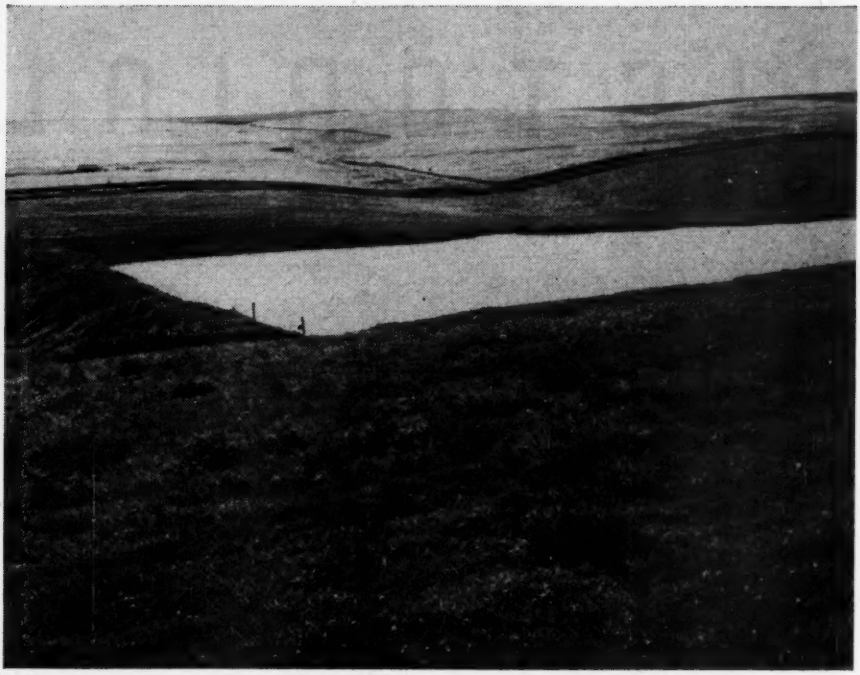
Limestone has proved to be highly profitable on all land upon which it was used. When these experiment fields were started there was no means of determining accurately the soils' need for lime and as a result limestone was put on at a rather heavy rate. Over the 40 years the amounts applied averaged

(*Turn to page* 45)

PICTORIAL



Daydreams

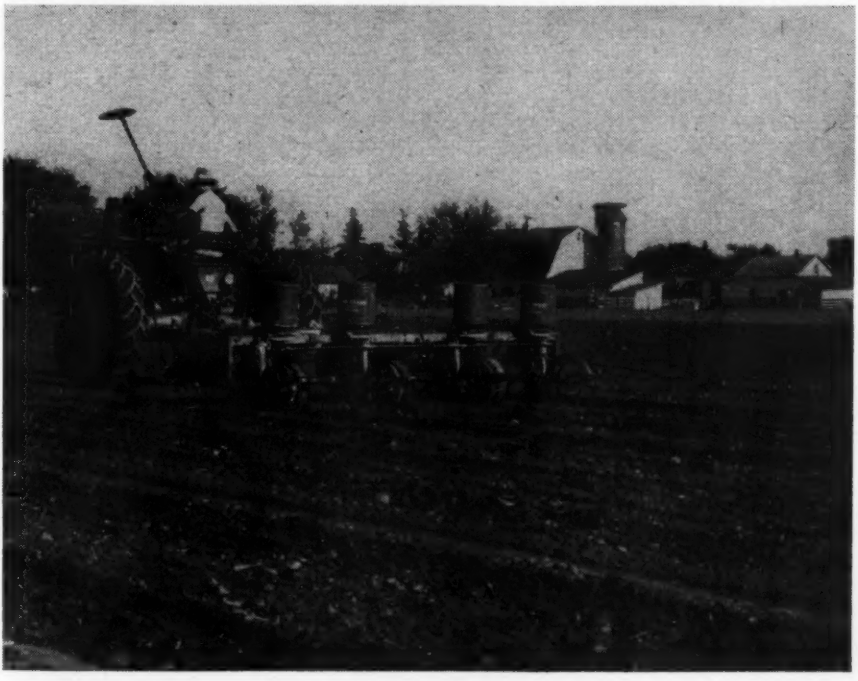


Above: This pond is stocked with fish and is also used for watering cattle.

Below: Planting sweet corn at the Crookham Co. Nursery, Caldwell, Idaho.

Above: A farmer and his county agent discuss problems in pasture management.

Below: Corn planting time on Dan McAllister's farm, Mt. Pleasant, Iowa.



Above: Good highways have ended the comparative isolation of many small towns.

Below: One of Iowa's traveling post offices on its daily run to small towns.

The Editors Talk

Our Cover Page

Sugar beets have a very high requirement for potassium. This fact is demonstrated year after year in fertility trials with sugar beets on the Muck Soil Experimental Farm conducted by Michigan State College.

The colored cover page illustrates three stages or degrees of abnormality or breakdown of sugar beet leaves due to inadequate potassium. The first symptom noted will be a yellowing of the margins near the tips of the leaves. Second, this yellowing may extend farther into the leaf, between the veins, followed by necrosis and browning of these tissues. In cases of severe and prolonged potassium starvation, leaf margins and interveinal tissues disintegrate, leaving a ragged, serrated condition.

The most severe symptoms are found on plots receiving phosphate alone. Moderate hunger signs usually appear on plots which have received 50 pounds K_2O annually for several years. Slight symptoms are noted at times on a plot with 100 pounds K_2O along with 200 pounds P_2O_5.

In connection with recent tissue test studies it was observed that definite potassium deficiency symptoms appeared when the water extractable potassium in sugar beet petioles was less than about 1,800 p.p.m. of K. With only 50 pounds K_2O added per acre, the potassium in the petioles went down from about 3,800 p.p.m. on July 11, 1951, to about the 1,000 p.p.m. level by August 18, where it remained through September. Where 100 pounds K_2O were applied, the p.p.m. of K in petioles went from about 5,000 on July 11 to less than 2,500 by August 18, with only a slight rise in September. With 150 pounds K_2O equivalent added, as recommended, potassium in petioles went from above 5,000 p.p.m. K on July 11 to about 2,800 p.p.m. by August 18, but recovered to above 4,500 during September.

More studies of this type are needed for many crops to correlate the nutrient content of plants at various stages of growth with both the appearance of symptoms and the total nutrient requirements for optimum growth.

Potash has been called the "sugar maker." In these experiments on muck soils, high potash in fertilizers is one of the main factors favoring production of high yields of sugar beets with a satisfactory sugar content. For further details on this research, read the article by Dr. J. F. Davis, "The Production of Sugar Beets on Organic Soils," in this issue.

New "Land"

Friends of the Land have a new publication. Regretting suspension of their old magazine, "The Land," the Society has circulated Series I, Spring 1955, of its new quarterly, "Land and Water."

Through its educational work during the past 15 years, Friends of the Land have become widely known as a "non-profit, non-partisan society for conserva-

tion of Soil, Rain, and Man." By means of the new publication, members will be kept informed about the four field projects of the Society: Home Watershed Management; the Relationship of Soil, Food, and Health; the Wise Use of Home Acres; and the Appraisal of the Progress Made in Soil and Water Conservation and the Obstacles in Its Way.

The first issue was designed to be, and is in fact, a manual on small watershed management. It explains how one can initiate a movement for better management on the watershed where he lives. The next issue will be devoted to Soil-Food-Health relationship. Obviously, both are of more than usual interest to the urban as well as the rural dweller.

The Society is to be congratulated on the continuance of its high standards of inspirational work toward awakening the consciousness of every one to the need for conservation. To quote Louis Bromfield, internationally known author and Chairman of the Board for Friends of the Land, "Conservation of our natural renewable resources is a matter of primary concern for every individual in this country today. Our resources are vital factors in our national economy, national defense, and equally important, in the physical and spiritual welfare of our people. We, the American people, are only trustees of our basic renewable resources—soils, waters, forests, and the living things that inhabit them. God has given us these riches to use intelligently. It is not intended that we dissipate this inheritance. As trustees, we must insure that these resources are improved and enriched, and passed along to the many generations yet to come."

Objectives

"Disseminating research information is one of the big needs of today. It's just as important as doing the research." That is what Dr. Byron T. Shaw, Administrator, Agricultural Research Service, told the American Agricultural Editors at their meeting in Washington, D. C., on May 2-4, 1955. We fully agree with Dr. Shaw. Webster defines research: "Studious inquiry; usually, critical and exhaustive investigation or experimentation having for its aim the revision of accepted conclusions, in the light of newly discovered facts." How would "the revision of accepted conclusions, in the light of newly discovered facts" be accomplished if these facts were not disseminated to those who can make use of them?

But, while the farm press deserves much credit for publicizing new "know-how," most credit must go to the information departments of the U. S. Department of Agriculture and the State Agricultural Colleges and Experiment Stations, to the extension services, teachers of vocational agriculture, and others working directly with the farmers. It is to these groups that growers turn when all in the written word is not understood.

Dr. Shaw stated that the total amount of money being spent for agricultural research, by States, by the Federal Government, and by industry, is about 300 million dollars a year. About a fourth of it comes through the Federal Government. Industrial research, it is estimated, costs 4 billion dollars a year. The Federal Government contributes well over half. On the basis of these ratios, he said, we have our job cut out for us if we are to help agriculture keep up with the rest of the economy.

That agriculture is holding its own is the big tribute to the forces disseminating the new information. To all of them must go gratitude and appreciation for their sincere and conscientious work toward better rural, and consequently urban, living.

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914....	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1928.....	18.0	20.0	53.2	118.0	84.0	99.8	11.22	34.17	....
1929.....	16.8	18.3	131.6	117.1	79.9	103.6	10.90	30.92	....
1930.....	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931.....	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932.....	6.5	10.5	38.0	54.2	31.9	38.2	6.20	10.33	....
1933.....	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934.....	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935.....	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936.....	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937.....	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938.....	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939.....	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940.....	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941.....	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942.....	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943.....	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944.....	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945.....	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946.....	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947.....	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948.....	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949.....	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950.....	40.1	51.7	91.7	173.0	153.0	200.0	16.70	86.50	....
1951.....	37.9	51.1	163.0	304.0	166.0	211.0	19.50	69.30	....
1952.....	34.6	49.9	198.0	338.0	153.0	209.0	19.95	69.60	....
1953.....	32.3	52.2	79.7	251.0	148.0	204.0	17.45	52.60	
1954									
May.....	32.17	58.0	134.0	263.0	147.0	200.0	17.05	51.40	....
June.....	32.31	53.0	151.0	270.0	149.0	191.0	15.65	51.40	....
July.....	32.18	52.7	149.0	302 0	150.0	200.0	15.15	54.00	....
August.....	34.00	48.2	141.0	259.0	153.0	203.0	16.45	61.30	....
September...	34 55	53.0	116.0	236.0	153.0	207.0	17.25	61.60	....
October.....	34.67	53.6	93.2	212.0	145.0	208.0	17.55	60.20	....
November...	33.17	52.0	109.0	216.0	137.0	212.0	18.15	59.40	....
December....	32.67	50.0	105.0	254.0	139.0	212.0	18.55	59.60	....
January.....	32.51	42.4	113.0	283.0	140.0	214.0	18.75	56.80	....
February.....	31.69	36.8	117.0	297.0	140.0	213.0	18.55	55.20	....
March.....	31.87	....	118.0	310.0	136.0	212.0	18.25	53.40	....
April.....	31.93	....	217.0	315.0	136.0	209.0	17.65	53.40	....
Index Numbers (Aug. 1909—July 1914 = 100)									
1928.....	145	200	76	134	131	113	95	152	147
1929.....	135	183	189	133	124	117	92	137	137
1930.....	77	128	131	123	93	76	93	98	128
1931.....	46	82	66	83	50	44	73	40	107
1932.....	52	105	55	62	50	43	52	46	100
1933.....	82	130	118	79	81	84	68	57	90
1934.....	100	213	64	91	127	96	111	146	94
1935.....	90	184	85	80	102	94	63	135	116
1936.....	100	236	164	106	163	116	94	148	108
1937.....	68	204	76	89	81	109	74	87	114
1938.....	69	196	80	79	76	64	57	97	96
1939.....	73	154	100	84	88	78	67	94	98
1940.....	80	160	78	97	96	77	64	96	122
1941.....	137	264	116	105	117	107	82	211	138
1942.....	153	369	168	134	143	124	91	202	178
1943.....	160	405	188	235	174	154	125	231	270
1944.....	167	420	214	216	170	160	139	234	236
1945.....	181	366	205	232	198	170	127	227	240
1946.....	263	382	178	248	212	209	141	319	217
1947.....	257	380	232	248	336	259	148	381	262
1948.....	245	482	222	253	201	226	155	298	253
1949.....	231	459	184	244	193	213	139	192	232
1950.....	323	517	132	197	238	226	141	384	211
1951.....	306	512	233	346	259	239	164	307	269
1952.....	279	499	284	385	238	236	168	309	274
1953.....	260	522	114	286	231	231	147	233	240
1954									
May.....	259	580	192	300	229	226	144	228	279
June.....	261	530	217	308	232	216	132	228	200
July.....	260	527	214	344	234	226	128	239	243
August.....	274	482	202	295	238	230	139	272	223
September...	279	530	166	269	238	234	145	273	170
October.....	280	536	134	241	226	235	148	267	191
November...	268	520	156	246	213	240	153	263	237
December....	263	500	151	289	217	240	156	264	216
January.....	262	424	162	322	218	242	158	252	263
February....	256	368	168	338	218	241	156	245	258
March.....	257	...	169	353	212	240	154	237	274
April.....	258	...	311	359	212	236	149	237	264

Wholesale Prices of Phosphates and Potash **

	Superphosphate, Baltimore, per unit	Florida land pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports [2]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports [2]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1928	.580	3.12	5.50	.669	.957	26.46	.607
1929	.609	3.18	5.50	.672	.962	26.59	.610
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951	.813	3.98	5.47	.401	.780	15.25	.200
1952	.849	3.98	5.47	.401	.793	15.25	.200
1953	.878	....	....	....	.793	15.25	.200
1954							
May	.895	....	....	.430	.827	16.00	.210
June	.895	....	....	.359	.710	13.45	.174
July	.895	....	....	.388	.765	14.75	.184
August	.895	....	....	.388	.765	14.75	.184
September	.895	....	....	.388	.765	14.75	.184
October	.895	....	....	.388	.765	14.75	.184
November	.895	....	....	.388	.765	14.75	.184
December	.895	....	....	.405	.825	16.00	.193
January	.895	....	....	.405	.825	16.00	.193
February	.895	....	....	.405	.825	16.00	.193
March	.895	....	....	.405	.825	16.00	.193
April	.895	....	....	.405	.825	16.00	.193
			Index Numbers (1910-14 = 100)				
1928	108	86	113	94	100	109	92
1929	114	88	113	94	101	110	93
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951	152	110	112	72	82	63	83
1952	158	110	112	72	83	63	83
1953	164	...	...	73	83	63	83
1954							
May	167	...	...	76	87	66	85
June	167	...	...	66	75	56	79
July	167	...	...	70	80	61	81
August	167	...	...	70	80	61	81
September	167	...	...	70	80	61	81
October	167	...	...	70	80	61	81
November	167	...	...	70	80	61	81
December	167	...	...	72	87	66	83
January	167	...	...	72	87	66	83
February	167	...	...	72	87	66	83
March	167	...	...	72	87	66	83
April	167	...	...	72	87	66	83

Wholesale Prices of Ammoniates **

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1928	2.67	2.30	7.06	6.63	4.92	6.00
1929	2.57	2.04	5.64	5.00	4.61	5.72
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951	3.16	1.97	13.20	10.92	10.18	10.09
1952	3.34	2.09	13.95	11.27	9.72	9.16
1953	3.26	2.27	11.04	11.19	7.39	7.09
1954						
May	3.09	2.22	11.40	12.15	11.47	10.74
June	3.09	2.18	10.76	12.15	10.09	9.87
July	3.09	2.18	11.12	11.28	10.02	9.87
August	3.09	2.18	12.37	11.19	9.83	11.19
September	3.09	2.18	11.51	10.85	9.78	10.09
October	3.01	2.18	11.55	11.26	9.64	9.94
November	2.98	2.18	11.85	11.78	8.80	9.23
December	2.98	2.18	11.98	12.41	8.50	8.35
January	2.98	2.18	12.00	12.35	8.32	8.32
February	2.98	2.18	11.16	12.23	8.50	8.50
March	2.98	2.18	10.47	12.45	7.82	7.82
April	2.98	2.18	9.90	12.41	6.68	6.23
Index Numbers (1910-14 = 100)						
1928	100	81	202	188	146	170
1929	96	72	161	142	137	162
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951	118	69	377	310	302	287
1952	125	74	399	319	288	260
1953	122	80	315	317	219	201
1954						
May	115	78	326	344	340	305
June	115	76	307	344	299	280
July	115	76	318	320	297	280
August	115	76	353	317	292	317
September	115	76	329	307	290	287
October	112	76	330	319	286	282
November	111	76	339	334	261	262
December	111	76	342	352	252	237
January	111	76	343	350	247	236
February	111	76	319	346	252	241
March	111	76	299	353	232	222
April	111	76	283	352	198	177

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and all Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1928.....	148	152	141	121	87	177	108	97
1929.....	148	150	139	114	79	146	114	97
1930.....	125	140	126	105	72	131	101	99
1931.....	87	119	107	83	62	83	90	99
1932.....	65	102	95	71	46	48	85	99
1933.....	70	104	96	70	45	71	81	95
1934.....	90	118	109	72	47	90	91	72
1935.....	109	123	117	70	45	97	92	63
1936.....	114	123	118	73	47	107	89	69
1937.....	122	130	126	81	50	129	95	75
1938.....	97	122	115	78	52	101	92	77
1939.....	95	121	112	79	51	119	89	77
1940.....	100	122	115	80	52	114	96	77
1941.....	124	130	127	86	56	130	102	77
1942.....	159	149	144	93	57	161	112	77
1943.....	193	165	151	94	57	160	117	77
1944.....	197	174	152	96	57	174	120	76
1945.....	207	180	154	97	57	175	121	76
1946.....	236	197	177	107	62	240	125	75
1947.....	276	231	222	130	74	362	139	72
1948.....	287	250	241	134	89	314	143	70
1949.....	250	240	226	137	99	319	144	70
1950.....	258	246	232	132	89	314	142	72
1951.....	302	271	258	139	93	331	152	76
1952.....	288	273	251	144	98	333	158	76
1953.....	258	262	247	139	100	269	164	77
1954								
May.....	258	267	250	147	96	338	167	80
June.....	248	265	248	141	95	311	167	69
July.....	247	263	248	142	95	310	167	74
August....	251	264	248	143	95	319	167	74
September.	246	263	248	142	95	308	167	74
October...	242	262	248	141	94	308	167	74
November.	244	262	248	140	93	301	167	74
December..	239	261	245	140	93	300	167	77
January...	244	264	248	140	93	297	167	77
February..	245	264	248	139	93	291	167	77
March....	244	265	248	137	93	275	167	77
April.....	247	265	248	135	93	252	167	77

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.

[2] Potash salts quoted F.O.B. mines; manure salts since June 1941; other carriers since June 1947. Beginning June 1954, muriate of potash quoted on both mine and port basis.

**** Where range of prices for fertilizer material is quoted, average figure is used. The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Analyses of Official Fertilizer Samples, Semi-Annual Report, Spring Season, January-June, 1954," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Regulatory Bul. 118, Dec. 1954.

"Maryland Fertilizer Facts for 1954," State of Md. Inspection and Regulatory Service, College Park, Md.

"The Effect of Trace Elements on Alfalfa and Oats in Minnesota," Agr. Exp. Sta., Univ. of Minn., St. Paul, Minn., Tech. Bul. 213, March 1955, J. M. MacGregor and J. F. Mulvehill.

"Cotton Yields in the El Paso Valley as Influenced by Time of Application of Ammonium Nitrate and Superphosphate, 1953," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1647, Feb. 1954, P. D. Christensen and P. J. Lyerly.

"Distribution of Fertilizer Sales in Texas, July 1 to December 31, 1954," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1754, Feb. 1955, J. F. Fudge.

"Anhydrous Ammonia as a Fertilizer," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., L-194, M. K. Thornton.

"Corn Fertilizer Tests at Several Locations in the Central Blacklands, 1953-54," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1761, March 1955, R. P. Bates and J. W. Collier.

"Inspection of Commercial Fertilizers and Agricultural Lime Products for 1954," Agr. Exp. Sta., Univ. of Vt., Burlington, Vt., Rpt. 28, Nov. 1954.

"A Comparison of Phosphate Fertilizers for Alfalfa on Irrigated Central Washington Soils," Agr. Exp. Stas., State College of Wash., Pullman, Wash., Stas. Cir. 257, Oct. 1954, R. L. Hausenbuiller and W. H. Weaver.

Soils

"Mechanical Analysis of Soils," Engin. Exp. Sta., Iowa State College, Ames, Iowa, Engin. Rpt. 21, 1954-1955, D. T. Davidson and Associates.

"Liming Kansas Soils," Agr. Exp. Sta., Kans. State College, Manhattan, Kans., Cir. 313, Sept. 1954, R. Ellis, Jr.

"Our Soil to Use," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Ext. Bul. 260, June 1954.

"Important Grasses on Montana Ranges," Agr. Exp. Sta., Mont. State College, Bozeman, Mont., Bul. 500, Oct. 1954, H. E. Morris, W. E. Booth, G. F. Payne, and R. E. Stitt.

"Soil Structure Studies With Synthetic Conditioners," Agr. Exp. Sta., Pa. State Univ., State College, Pa., Bul. 586, Dec. 1954, R. B. Alderfer.

"Vegetable Garden Soil Management," Agr. Ext. Serv., Pa. State Univ., State College, Pa., Cir. 439, R. F. Fletcher.

"Water Evaporation Studies in Texas," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Bul. 787, Nov. 1954, D. W. Bloodgood, R. E. Patterson, and R. L. Smith, Jr.

"Seventh Report of State Soil Conservation Committee, July 1, 1952-June 30, 1954," State Dept. of Agr., Montpelier, Vt.

"Irrigation Structures and Methods for Water Control," Agr. Ext. Serv., State College of Wash., Pullman, Wash., Ext. Bul. 491, Sept. 1954, M. C. Jensen, M. A. Hagood, and P. K. Fanning.

"Land Judging, Learning to Know Your Soil," Agr. Ext. Serv., W. Va. Univ., Morgantown, W. Va., Misc. Pub. 26, 1954, G. Sharpe, B. J. Patton, and G. G. Pohlman.

"The Changing Fertility of New England Soils," USDA, Wash., D. C., Agr. Inf. Bul. 133, Dec. 1954.

"Soil Survey, Decatur County, Tennessee," USDA, Wash., D. C., Series 1941, No. 12.

Crops

"Flowers for Alaska," Agr. Exp. Sta., Univ. of Alas., Palmer, Alas., Ext. Cir. 400, Rev. June 1954, A. S. Buswell and A. Kallio.

"1954 Corn Performance Test on Rice Prairie and Similar Soils," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Mimeo. Series 27, Dec. 1954, J. O. York.

"Arkansas Coastal Plain Corn Performance Test for 1954," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Mimeo. Series 28, Dec. 1954, J. O. York.

"Eastern Arkansas Corn Performance Tests

for 1954," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Mimeo. Series 29, Jan. 1955, J. O. York.

"Artichokes, How to Grow Them in California," Agr. Exp. Sta., Univ. of Calif., Berkeley, Calif., Lflt. 37, Oct. 1954, A. A. Tavernetti.

"Alfalfa Production in California," Agr. Exp. Sta., Univ. of Calif., Davis, Calif., Cir. 442, Nov. 1954, E. H. Stanford, L. G. Jones, V. P. Osterli, B. R. Houston, R. F. Smith, and A. D. Reed.

"Agricultural Progress in Ontario, 1837-1953," Dept. of Agr., Ottawa, Ontario, Can.

"Cereal Crops Division, Central Experimental Farm, Ottawa, Progress Report 1949-1953," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., C. H. Goulden.

"Forage Crops Division, Central Experimental Farm, Ottawa, Ont., Progress Report 1949-1953," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., Feb. 1955, T. M. Stevenson.

"Melfort, Saskatchewan, Experimental Station, Progress Report 1947-1953," Dept. of Agr., Ottawa, Ont., Can., Nov. 1954, H. E. Wilson.

"Forage Crops Division and Laboratory, Saskatoon, Saskatchewan, Progress Report 1949-1953," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., Jan. 1955, W. J. White.

"Cover Crop Tests in Furrow Irrigated Orchards in British Columbia," Exp. Sta., Summerland, B. C., Can., Pub. 917, Nov. 1954, J. C. Wilcox.

"Potato Growing in Canada," Dept. of Agr., Ottawa, Ont., Can., Pub. 918, Jan. 1955, N. M. Parks.

"Research Serves Colorado Agriculture, 65th Ann. Rpt. for the fiscal year July 1, 1951 to June 30, 1952," Agr. Exp. Sta., Colo. A. & M. College, Fort Collins, Colo.

"Lawns," Agr. Exp. Sta., Univ. of Conn., Storrs, Conn., Cir. 190, Feb. 1955, H. G. M. Jacobson, H. A. Lunt, F. W. Meyer, and J. C. Schread.

"Year-Round Grazing on a Combination of Native and Improved Pasture," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 554, Nov. 1954, D. W. Jones, E. M. Hodges, and W. G. Kirk.

"Effects of Size and Spacing of Whole and Cut Seed on Yields and Returns from Sebago Potatoes at Hastings, Florida," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 556, Jan. 1955, E. N. McCubbin.

"Flatwoods Farm Woodland Improvement Pays," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Cir., 125, Nov. 1954, W. H. D. McGregor.

"Mist Propagation," Agr. Ext. Serv., Univ. of Fla., Gainesville, Fla., Cir. 127, Feb. 1955, J. N. Joiner and T. J. Sheehan.

"Caladium Production in Florida," Agr. Ext. Serv., Univ. of Fla., Gainesville, Fla., Cir. 128, Feb. 1955, T. J. Sheehan.

"Lawns," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Cir. 380, Nov. 1954, T. G. Williams.

"Sweet Potato Performance Trials in the Georgia Piedmont," Agr. Exp. Sta., Univ. of Ga., Athens, Ga., Mimeo. Series N. S. 3, Dec. 1954, A. H. Dempsey, B. B. Brantley, and M. Speirs.

"1954 Georgia Corn Performance Trials," Agr. Exp. Sta., Univ. of Ga., Athens, Ga., Dec. 1954, G. A. Lebedeff, A. A. Fleming, S. B. Parkman, J. W. Dobson, G. Kozelnicky, and L. F. Bauman.

"1953 Vegetable Variety Trials in Hawaii," Agr. Exp. Sta., Univ. of Hawaii, Honolulu, Hawaii, Sta. Progress Notes 106, Aug. 1954, D. C. McGuire, M. G. Nakasato, and J. C. Gilbert.

"Crop Varieties for Illinois," Agr. Ext. Serv., Univ. of Ill., Urbana, Ill., Cir. 731, Oct. 1954, W. O. Scott and J. C. Hackleman.

"Your Division of Agriculture Reports, for the Year July 1, 1953 to June 30, 1954," Agr. Exp. Sta., Iowa State College, Ames, Iowa.

"Your Experiment Station Reports for the Two Years, July 1, 1951 to June 30, 1953," Agr. Exp. Sta., Iowa State College, Ames, Iowa.

"Sudangrass in Kansas, Including the New Greenleaf Variety," Agr. Exp. Sta., Kans. State College, Manhattan, Kans., Cir. 311, Aug. 1954, R. C. Pickett.

"Home Gardening in Maine," Agr. Exp. Sta., Univ. of Maine, Orono, Maine, Bul. 419, March 1955, R. W. Paulson.

"Ten Tips for Successful Seedings," Agr. Ext. Serv., Univ. of Maine, Orono, Maine, Cir. 297, April 1955.

"Oats—Maine's No. 1 Grain," Agr. Ext. Serv., Univ. of Maine, Orono, Maine, Ext. Serv. Cir. 299, April 1955, P. N. Mosher.

"Lawn Care," Agr. Ext. Serv., Univ. of Maine, Orono, Maine, Cir. 301, April 1955, L. P. Bissell.

"Fruit Varieties for Minnesota," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Ext. Bul. 224, Rev. March 1955, O. C. Turnquist and L. C. Snyder.

"Vegetable Varieties in Minnesota," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Ext. Fldr. 154, Rev. March 1955, O. C. Turnquist.

"1954 Cotton Variety and Irrigation Tests in the Hill Sections of Mississippi," Agr. Exp. Sta., Miss. State College, State College, Miss., Bul. 525, Jan. 1955, E. A. Kimbrough and J. F. O'Kelly.

"Growing and Using Rhubarb," Agr. Ext. Serv., Univ. of Mo., Columbia, Mo., Cir. 644, Jan. 1954, C. R. Cunningham, V. N. Lambeth, and F. L. Carl.

"Grow Your Vegetables," Agr. Ext. Serv., Univ. of Mo., Columbia, Mo., Cir. 645, Jan. 1954, C. R. Cunningham and V. N. Lambeth.

"Christmas Trees, a Cash Crop," Agr. Ext. Serv., Univ. of N. H., Durham, N. H., Ext.

Bul. 123, Aug. 1954, K. E. Barraclough and R. H. K. Phipps.

"A Comparison of Birdsfoot Trefoil and Ladino Clover in an Irrigated Pasture Mixture," Agr. Exp. Sta., N. Mex. A. & M. College, State College, N. Mex., Press Bul. 1128, Nov. 1954, H. Jones.

"Strawberry Growing," Agr. Exp. Sta., Cornell Univ., Ithaca, N. Y., Ext. Bul. 923, Nov. 1954, M. B. Hoffman.

"Dixie Bright 28, a High-Yielding, Bacterial Wilt-Resistant, Flue-Cured Tobacco Variety," Agr. Exp. Sta., N. C. State College, Raleigh, N. C., Bul. 393, Dec. 1954, E. L. Moore and E. E. Clayton.

"Which Hard Red Spring Wheat to Grow in 1954," Agr. Exp. Sta., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-203, Jan. 1954, T. E. Stoa.

"Which Durum to Grow in 1954," Agr. Exp. Sta., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-204, Jan. 1954, T. E. Stoa.

"Grow More Corn for Silage, Feed Reserves and Weed Control," Agr. Exp. Sta., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-206, Feb. 1954, W. Wiidakas, R. B. Widdifield, R. J. Douglas, and T. J. Conlon.

"Light Weight Durum for Seed," Agr. Ext. Serv., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-208, March 1954, R. B. Widdifield and C. M. Swallers.

"Grow Better Pastures With Grasses and Legumes," Agr. Ext. Serv., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-209, March 1954, J. F. Carter, W. C. Whitman, I. T. Dietrich, and V. Weiser.

"Make Pastures Pay; Cash in With Better Pastures," Agr. Ext. Serv., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-210, March 1954, J. F. Carter, W. C. Whitman, I. T. Dietrich, and V. Weiser.

"Fruit Varieties for North Dakota," Agr. Ext. Serv., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-214, June 1954, H. Graves and J. H. Schultz.

"1955 Recommendations for Wheat and Durum," Agr. Exp. Sta., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-220, Feb. 1955, T. W. Stoa and R. B. Widdifield.

"Oklahoma Agriculture 1954," State Dept. of Agr., Okla. City, Okla.

"Agricultural and Home Economics Extension and the Centennial, 1855-1955," Pa. State Univ., State College, Pa., Ann. Rpt. 1954.

"67th Annual Report of the Pennsylvania Agricultural Experiment Station," Agr. Exp. Sta., Pa. State Univ., State College, Pa., Bul. 578, July 1954, M. S. Eisenhower.

"Agricultural Progress in South Carolina, Balancing a Changing Agriculture 1953," Agr. Exp. Sta., Clemson Agr. College, Clemson, S. C., Ann. Rpt. 1953.

"Progress in Agricultural Research at the North Central Substation," Agr. Exp. Sta., S. Dak. State College, Brookings, S. Dak., Cir. 103, April 1954.

"Rescuegrass," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., L-211, E. M. Trew.

"Buffelgrass," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., L-213, E. M. Trew.

"Berseem Clover," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., L-216, E. M. Trew.

"Cotton Variety Tests in Fort Bend County, 1953," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1643, Feb. 1954, E. R. Cozart and J. C. Smith.

"Texas Watermelon Variety Trials, 1951-53," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1645, Feb. 1954, H. C. Mohr, A. L. Harrison, H. C. Hutson, G. L. Smith, and V. I. Woodfin.

"Winter Garden Cotton Variety Test, 1954," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1758, Feb. 1955, C. S. Hoveland.

"Soybean Variety Test, El Paso Valley, 1954," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1760, March 1955, M. D. Bryant and P. J. Lyerly.

"Grain Sorghum Variety Tests at Temple, 1949-54," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1762, March 1955, R. P. Bates and J. W. Collier.

"Pecan Orchard Management," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., B-162, Rev. March 1953, J. F. Rosborough, F. R. Brison, J. E. Hutchison, B. G. Hancock, and A. H. Krezdorn.

"Research on Rice Production in Texas," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., B-225, May 1954, E. B. Reynolds.

"Biennial Report of the Utah Agricultural Experiment Station 1952-54," Agr. Exp. Sta., Utah State Agr. College, Logan, Utah, Bul. 373, Dec. 1954.

"Factors Affecting Quality of Alfalfa Hay," Agr. Ext. Serv., Utah State Agr. College, Logan, Utah, Cir. 204, July 1953, G. T. Baird.

"Fifty Years of Dry Land Research at the Nephi Field Station," Agr. Exp. Sta., Utah State Agr. College, Logan, Utah, Bul. 371, Oct. 1954, W. H. Bennett, D. W. Pittman, D. C. Tingey, D. R. McAllister, H. B. Peterson, and I. G. Sampson.

"Planting and Renewal of Apple Orchards in Vermont," Agr. Ext. Serv., Univ. of Vt., Burlington, Vt., Brieflet 923, C. L. Calahan.

"Growing Safflower in Washington," Agr. Ext. Serv., State College of Wash., Pullman, Wash., Ext. Misc. Pub. 26, Sept. 1954, K. J. Morrison.

"Science Serves Your Farm," Agr. Exp. Sta., W. Va. Univ., Morgantown, W. Va., Bul. 369, Part 1, Fall 1954, C. J. Cunningham and E. A. Livesay.

"Science Serves Your Farm," Agr. Exp. Sta., W. Va. Univ., Morgantown, W. Va., Bul. 369, Part 2, Winter 1954, H. R. Varney.

Economics

"How Much Will It Cost to Change Your Citrus Orchard?" Agr. Exp. Sta., Univ. of Calif., Berkeley, Calif., Lflt. 36, Oct. 1954, M. P. Miller and W. Sullivan.

"Twenty-Two Years of Citrus Costs and Returns in Florida, 1931-1953," Agr. Ext. Serv., Univ. of Fla., Gainesville, Fla., Ext. Serv. Econ. Series 55-1, Feb. 1955, Z. Savage.

"Florida's Land Resources and Land Use," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 555, Nov. 1954, L. A. Reuss.

"How Many Citrus Trees Per Acre?" Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Econ. Series 55-2, April 1955, Z. Savage.

"Florida Agriculture and Public Problems," State Dept. of Agr., Tallahassee, Fla., No. 157, 1954, T. J. Brooks.

"Agricultural and National Finance," State Dept. of Agr., Tallahassee, Fla., Bul. 159, Aug. 1954, T. J. Brooks.

"Industrial Engineering and Economic Studies of Peanut Marketing," Engin. Exp. Sta., Univ. of Ga., Athens, Ga., Bul. 286, Dec. 1954, J. J. Moder, Jr. and N. M. Penny.

"Georgia's 1955 Agricultural Outlook for Farm and Home Development," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Cir. 382, Nov. 1954, C. R. O'Kelley.

"Adapting Western Kansas Farms to Uncertain Prices and Yields," Agr. Exp. Sta., Kans. State College, Manhattan, Kans., Tech. Bul. 75, Feb. 1954, E. N. Castle.

What Is Happening to Our Citrus Soils?

(*From page* 14)

siderable amount of work which has been carried out and is still under way.

The sensitivity of citrus, and especially the lemon, to alkali salts has been recognized for many years. In California, Lougridge and Hilgard and later Kelley (15) recognized this fact and the latter did a great deal of further research showing the essential nature of alkali soils, the principles of reclamation, and how alkali soils are formed.

Some of the things we still have insufficient information about are: (1) The concentration of various constituents individually and combined at which any given citrus specie and rootstock combination under a given climatic complex begin to be adversely affected; (2) the best way to irrigate and manage a soil under a given cropping-soil-fertilizer-water quality-climate situation, and (3) the secondary effects of salt build-up on soil-plant interrelations especially as it concerns the availability of essential elements, physical changes in the soil, and the biological complex.

In order to illustrate some of the findings which have emerged from the two aforementioned lines of work (i.e., lysimeter and salinity trend experiments), some sample data are presented in what follows.

Lysimeter Experiment

In a lysimeter experiment, as already stated, we have measured all of the individual constituents added in irrigation water, fertilizer, seed, and straw and we have measured crop removal and leaching losses, thus enabling us to determine the trend of each major constituent and the sum of these (6). In Table VI is a 15-year summary showing the average for all lysimeters of (1) the total salts added, (2) the total removed, and (3) the balance. Under the conditions of this experiment, it will be noted that there has been a net gain amounting to about 1,000 pounds of salt per acre per year.

TABLE VI.—LYSIMETER SALT BALANCE AFTER 15 YEARS OF CROPPING & FERTILIZATION.

LBS./TOTAL SALT/ACRE

Soil treatment	Added in irrig. water, fertilizer, and seed	Removed by crops and leaching	Gain or loss
Straw + 200 lbs. N	25,074	10,332	+14,742
Melilotus + 200 lbs. N	28,216	10,849	+17,367

The changes in individual constituents are shown in Table VII. It is readily apparent that the 1,000 pounds per year gain consists essentially of calcium and sodium bicarbonate, with smaller gains in sulfate and chloride. The irrigation water used in this experiment is comparatively pure mountain water containing about 350 ppm. total soluble solids, and the annual average rainfall is 11 inches. Fertilization was at an annual rate of 200 pounds nitrogen as calcium nitrate.

The amounts of irrigation water applied were such as to meet crop needs only. It is well known that to keep the salts flushed out of an irrigated soil a certain surplus of water must be used. It has been estimated by us (6) that water in excess of transpiration-evaporation requirement in the amount of 9% would have to percolate through this soil in order to keep salts from building up above a certain equilibrium level. This figure will vary depending upon the salt content of the water. Eaton (10) has referred to this as the drainage requirement of a water and has set up formulas for calculation for any given water quality the percentage of applied irrigation water which must be wasted by drainage in order to assure reasonable yields. Also included in the formulas are the gypsum requirements. These formulas represent a significant advance and provide a type of guidance not hitherto available.

TABLE VII.—SOIL CHANGES DURING 15 YEARS OF CROPPING AND FERTILIZATION UNDER IRRIGATION AGRICULTURE.

Constituent	Net gain or loss under two cropping systems[1]	
	Vetch + 200 lbs. N	Mustard + 200 lbs. N
	lbs/acre	lbs/acre
Calcium	+ 5,573	+ 6,189
Magnesium	− 194	− 17
Potassium	− 3,265	− 3,552
Sodium	+ 2,005	+ 1,913
Nitrogen	+ 853	− 448
Phosphorus	− 244	− 227
Sulfur	+ 382	+ 399
Chloride	+ 234	+ 119
Bicarbonate	+13,058	+12,203

[1] Vetch and mustard cover crops respectively grown in winter and turned under in spring; harvested crop of Sudan grass grown in summer.

Salinity Trend

In a salinity trend study we have determined yearly under a range of soil and cropping conditions the salinity status of the top six feet of soil by one foot horizons. The soluble salt situation in the first, second, and third foot of soil and the total found in the upper six feet of soil for two citrus groves was studied over a 16-year period. In an orange orchard in Ventura County, sampled first in 1936, the total salt in the six feet of soil increased from approximately 18,000 to 63,000 pounds per acre from 1936 to 1953. This large increase is due primarily to the years of lower-than-average rainfall we have had in California since 1942 and failure to keep the salts flushed out by increased irrigation. In 1941 following the high seasonal rainfall of 35.7″ the total salt decreased from 29,928 to 14,880 pounds. This demonstrates the rapidity with which salt will move out of a well-drained soil under the influence of leaching rains. The following year, however, the salt was back up to 26,640 pounds. It is certain that part of this increase was due to capillary movement upward from levels below six feet; all of it could not have accrued from the irrigation water applied between June of 1941 to June of 1942.

Similar type data on a lemon orchard were obtained in the Oxnard Plain area where high water table and high salt have been perennial problems. The water table at the time we started sampling was at 4.0 feet; later, through improved drainage, it dropped to below 5.5 feet and has stayed down. However, there was an oscillation of salt from year to year in the various horizons. This up and down movement is

in response to the combined influence of rainfall, irrigation, and climatic conditions. The fact that after 16 years, salt is not much different than at the outset indicates that the drainage water is carrying away about as much salt as the irrigation water is bringing in but that no permanent gain is being made on the salt picture. In years of higher rainfall the salt is pushed out of the first three feet of soil into lower horizons, but moves back up by capillarity in succeeding years. This lemon orchard shows substantial salt injury all of the time as well as manganese and iron chlorosis. Despite this condition, fairly good yields of lemons are obtained. This orchard is located near the coast where temperatures are prevailingly low and humidity high. In desert regions this much salt would probably render lemons completely unproductive.

These and other data point to the importance of securing much more data on the interrelations of irrigation practice, drainage performance, rainfall, and other management practices as related to salt movement, accumulation, equilibrium levels, and the combined impact on citrus performance.

Another aspect of salinity to which we have given some attention is the accumulation of salts in furrow crests (13). This problem assumes special importance under non-cultivation. In Table VIII is shown the concentration and character of salts which have accumulated in the furrow crests of one of our orchards. It is commonly noted in the fall after the first rain that citrus trees often turn yellow. We think this is due to the leaching of the salts which have accumulated during the summer irrigation season down to the upper root zone. We believe that under non-cultivation, sprinkler irrigation may prove to be a better method of applying water; but in some areas we have actually seen more salt injury where sprinkler irrigation is practiced than under the furrow system. Special studies are now being made of this problem.

TABLE VIII.—SALT ACCUMULATIONS IN FURROW CRESTS OF CITRUS SOILS.[1]

Area	Depth	Concentration (M.E. Sat. Extr.)			
		Total salt	NO_3	Cl	Na
Furrow Bottom	0–6″	55	5	4	8
Furrow Crest	0–1″	3,040	2,320	650	986
	0–6″	656	447	152	303

[1] Robert B. Harding. Proc. Soil Sci. Soc. 18:369-372.

Physical Changes in Citrus Soils

Soils of the semi-arid regions where citrus is grown are commonly low in organic matter and in the loamy sands and heavier types are especially susceptible to physical deterioration.

In California and in many other regions where cultivation is practiced, compacted layers referred to as plow sole develop. These layers impede both water penetration and drainage. We do not know the exact importance of this as related to tree performance. We have come to feel that the improvement in tree condition which results from the practice of non-cultivation is due in part to the gradual disappearance of plow sole. However, much more information on this subject is needed.

In our long-time soil fertility plots at Riverside we demonstrated a few years ago that heavy annual applications of sodium nitrate and ammonium sulfate had so deflocculated the soil of the cultivated layer that irrigation water was running off instead of penetrating, salts were building up, and the combined effect produced a marked decline in the trees of these plots. Aldrich, Parker, and Chapman (1) found that an increase of exchangeable sodium from 0.07 to 0.77 m.e./per 100 grams of soil with a resulting change of Ca:Na ratio from 93:1 to 8:1 was sufficient to bring about marked changes in permeability and other properties. These

results illustrate the need for much more research to determine on a wide range of soils and under various fertilization, irrigation, and management practices what the ultimate effect is on physical status and tree performance.

Biological Changes

About 20 years ago the director of our station, Dr. L. D. Batchelor, began calling the attention of a number of us to the poor growth of replanted citrus orchards on old citrus lands. This later culminated in the organization of a broad research program under his direction aimed at ascertaining both the causes and possible remedies. Among the lines of work started was a series of greenhouse, field, and laboratory experiments by Martin of our staff whose research published in a series of papers (16) (17) (18) (19) (21) has shown that the growth of citrus in many soils results in a build-up of a biological flora which unfavorably affects subsequent citrus growth. He has shown that not one but a considerable number of fungal species are involved. This work also served to focus attention on the earlier work of Thomas (23) who showed that the citrus nematode, *Tylenchulus Semipenetrans,* was also a factor. Subsequent surveys by H. S. Reed and his associates (unpublished data) had shown that this nematode is universally present in California citrus orchards, and more recently Baines (5) has extended this work and confirmed the earlier work of Thomas. As a result of all these findings we are now convinced that a part of the replant difficulty is due to the development of this unfavorable flora. Martin also has produced evidence suggesting that possibly a slowly decomposable organic toxin specific for citrus also may accumulate in old citrus orchards. This unfavorable soil condition persists even when the soil is dug from the citrus orchard, potted, and planted to citrus seedlings in the greenhouse. In comparisons of the growth of citrus in potted soils from old citrus soils and adjacent non-citrus soils, growth is frequently less than half that of the non-citrus soil with a corresponding reduction in root development as shown in Figures 1 and 2. Feeder root rotting is usually noted in the roots of seedlings grown in the old citrus soil.

A further very significant finding is that the depressing effect found on old citrus soils is variable from soil to soil; on some there is virtually no effect, on others a pronounced effect. This indicates that soil conditions in some orchards are much less favorable for the development of an adverse flora than in others and one of our important objectives now is to find just what these soil conditions are.

As is well known, one of the important methods of making old citrus lands suitable for replanted citrus is soil fumigation. In this connection, however, it becomes important to determine the impact of this practice on long-term soil productivity. Preliminary studies by Aldrich and Martin (4) have been made to determine the chemical effects of several fumigants. These studies have shown increases in ammonia which then oxidizes to nitrate with an increase in soluble Ca, Mg, K, and Mn. In further investigations (20) little effect of fumigation was produced on soil aggregation, though there were large changes in microbial population and character

With the increasing use of soil fumigants, fungicides, and pesticides it is evident that here is another area where we need to take account of possible soil changes, both short term and long term.

Discussion and Conclusion

From the foregoing, it is evident that in the culture of citrus, or of any other plant, profound changes in the chemical, physical, and biological characteristics of soil take place as time goes on.

Fertilization, irrigation, and cultural practices generally have been more concerned with immediate performance than with the long-time changes taking

place. With decreasing land areas on the one hand and the need to both attain and maintain maximum production on the other, we must concern ourselves increasingly with the impact of a variety of fertilization, irrigation, and cultural practices on the soil in order to establish what is going on and avoid those practices which may in the end be very detrimental to soil productivity.

Literature Cited

1. Aldrich, D. G., Parker, E. R., and Chapman, H. D. 1945. Effects of several nitrogenous fertilization and soil amendments in the physical and chemical properties of an average irrigated soil. Soil Sci. 59:299-312.

2. Aldrich, D. G., and Haas, A. R. C. 1949. Response of lemon trees to phosphorus and potassium. Calif. Citograph 35(1):5, 22-24.

3. Aldrich, D. G., and Coony, J. J. 1952. A field response of citrus to phosphorus and potassium fertilization. Am. Soc. Hort. Sci. Proc. 59:13-21.

4. Aldrich, D. G., and Martin, J. P. 1952. Effect of fumigation on some chemical properties of soils. Soil Sci. 73:149-159.

5. Baines, R. C. 1950. Nematodes injurious to citrus roots. Citrus Leaves 30(6):24.

6. Broadbent, F. E., and Chapman, H. D. 1949. A lysimeter investigation of gains, losses, and balance of salts and plant nutrients in an irrigated soil. Soil Sci. Soc. Amer. Proc. 14: 261-269.

7. Chapman, H. D. 1934. The phosphate of Southern California soils in relation to citrus fertilization. Calif. Expt. Sta. Bul. 571, pp. 1-22.

8. Chapman, H. D., Brown, S. M., and Rayner, D. S. 1947. Effects of potash deficiency and excess on average trees. Hilgardia 17:619-650.

9. Chapman, H. D., and Rayner, D. S. 1951. Effect of various maintained levels of phosphate on the growth, yield, composition, and quality of Washington naval oranges. Hilgardia 20:325-328.

10. Eaton, Frank M. 1954. Formulas for estimating leaching and gypsum requirements of irrigation waters. Tex. Agr. Expt. Sta. Misc. Publication 111, pp. 1-18.

11. Embleton, T. W., Kirkpatrick, J. D., and Parker, E. R. 1952. Visible response of phosphorus-deficient orange trees to phosphatic fertilizers, and seasonal changes in mineral constituents of leaves. Proc. Am. Soc. Hort. Sci. 60:55-64.

12. Harding, Robert B. 1953. Soil phosphorous in California orange orchards in relation to yield, fruit size, and phosphorus in leaves. Am. Soc. Hort. Sci. 61:31-37.

13. Harding, Robert B. 1954. Surface accumulation of nitrates and other soluble salts in California orange orchards. Proc. Soil Sci. Soc. Amer. 18:369-372.

14. Kelley, W. P., Laurance, B. M., and Chapman, H. D. 1949. Soil salinity in relation to irrigation. Hilgardia 18:635-665.

15. Kelley, W. P. 1951. Alkali soils, their formation, properties, and reclamation. Reinhold Publishing Co., New York.

16. Martin, James P. 1948. Effect of fumigation, fertilization, and various other soil treatments on growth of orange seedlings in old citrus soils. Soil Sci. 66:273-288.

17. Martin, James P. 1950. Effect of various leaching treatments on growth of orange seedlings in old citrus soils. Soil Sci. 69:433-442.

18. Martin, James P. 1950. Effect of soil fungi on germination of sweet orange seeds and development of the young seedlings. Soil Sci. Soc. Amer. Proc. 14:184-188.

19. Martin, James P. 1950. Effects of fumigation and other soil treatments in the greenhouse on the fungus population of old citrus soil. Soil Sci. 69:107-122.

20. Martin, J. P., and Aldrich, D. G. 1952. Effect of fumigation on soil aggregation. Soil Sci. Soc. Amer. Proc. 16:201-203.

21. Martin, James P., and Batchelor, L. D. 1952. The difficulties of replanting lands to the same species of orchard trees. Proc. 6th Ann. Rio Grande Valley Hort. Inst., Weslaco, Texas, pp. 1-10. Jan. 16, 1952.

22. Martin, J. P., Harding, R. B., and Murphy, W. S. 1953. Effects of various soil exchangeable cation ratios on growth and chemical composition of citrus plants. Soil Sci. 76:285-295.

23. Thomas, E. E. 1923. The citrus nematode, *Tylenchulus Semipenetrans*. Calif. Expt. Sta. Bul. 2:1-35.

Pasture Improvement Through Renovation

(*From page* 20)

Versatility and use on the farm is of particular importance. Most of the more than 20 plantings on farms have been August or early September seedings following July applications of the herbicide. In two instances chemicals were applied about the first of September and small grains were seeded for grazing October 1. Orchardgrass seeded with the rye and ladino clover broadcast in late winter was established well. In one trial ladino clover broad-

cast the last of February established far better in plots having a mulched surface than on a seedbed which had been plowed. Other variations in farm application are easily conceived.

Of particular importance is the problem of dissipation of the chemical from the soil. Where TCA has been used, 30 to 35 days have been allowed to elapse after spraying before seedings were made. However, on two locations in 1953, insufficient rainfall was obtained between the time of applying the chemical and the time of seeding. The fall seedlings of rye and of bromegrass-ladino clover were killed. Both were reseeded successfully the following spring.

Reseeding within a reasonable length of time is essential. Aside from the loss of use of the grazing land, too great delay will permit weed seeds in the soil to germinate and a new weed problem will be presented. Where soil moisture content is high, about one inch of rain in 30 days has been adequate to leach 25 pounds of TCA per acre from the soil and permit safe reseeding. Where more chemical is used and rainfall is limited, more time is required between the spraying and seeding operation.

The cost of TCA is comparatively well fixed and the treatment of one acre costs between $12 and $14. Further, it is corrosive to equipment and hands. A cheaper, more dependable herbicide is required which will be effective against all species and at low rates.

In preliminary trials of only one-year duration, a dichloro propionic acid (Dalapon) at from 6 to 8 pounds and 3 amino 1, 2, 4-triazole (Amizol) at about 6 pounds per acre promise to give a more complete kill at about one half the cost of TCA. At the lower rates, dissipation should be more rapid. Their effectiveness, best time and methods of use, and duration in the soil must be established before they can be recommended with assurance.

Within the past few years special equipment has been designed to place seed directly into sod above a band of fertilizer and without tillage. The International Harvester Pasture Renovator and John Deere Grassland Drill are two such machines. At present they are most effective for use with small grains, but they offer good promise, with proper adjustments, for seeding smaller seeds. Several successful seedings of forage crops have been made on chemically treated sods in New Jersey with both of these machines.

As competition continues to bear on the American farmer, the incentive is ever present to increase the efficiency of production. In a livestock enterprise this has come to mean the full use of quality pasture as a less expensive feed. A practical and effective means is needed to convert millions of acres of neglected grazing land into productive pasture.

Soil Improvement Pays in Large Figures

(*From page* 26)

about 500 pounds an acre or near a ton every four years. On the high productive soils in the manure system, manure and limestone, the return from limestone averaged approximately $5.00 an acre or about $21.00 per ton. On the medium productive soils limestone used with manure returned approximately $12.00 an acre each year or $48.00 per ton. On the low productive soils, which were very acid to begin with, limestone gave a return of $27.00 an acre or $94.50 per ton. The sandy land returned a value of $18.50 an acre or $55.50 per ton.

Rock phosphate when first used on these fields was put on in rather large quantities and later the rate of application was cut down, so that during the past 8 years the rate was slightly in excess of 200 pounds an acre each year or approximately 800 pounds an acre

in the rotation. On this basis rock phosphate failed to show a significant increase on the high productive soils and the same was true also on the sandy land. This was in the manure system, manure, limestone, rock phosphate. Its use on the medium productive soils gave a return of $4.25 an acre or $39.00 per ton in increased crop yields. On the low productive soils rock phosphate gave a return of $3.75 an acre each year and on this basis was worth $34.00 per ton. This was in the combination of manure, limestone, and rock phosphate.

In the crop residue system which included the return of crop residues including legumes to supply soil organic matter and nitrogen, limestone and rock phosphate were used with the addition of a potash salt. During early years kainit was used as a potash carrier and for a time during the first world war a western potash salt was used. During later years a high-grade muriate of potash has been used at the rate of 100 pounds an acre each year or 400 pounds for the rotation. This was put on 200 pounds for corn, and 200 pounds for wheat.

Limestone in the residue system on the high productive soils returned $12.00 an acre or $53.50 per ton. On the medium productive soils the return for limestone in the residue system was $15.50 an acre each year or $61.25 per ton. On the low productive soils limestone returned $18.25 an acre or $64.00 per ton for the amount used. On the sandy land the return was $28.00 an acre or $84.50 per ton of limestone used in the residue system.

Rock phosphate in the crop residue system, residues, limestone, rock phosphate, on the high productive soils returned $5.00 per acre or $48.00 per ton. With rock phosphate on medium productive soils the return was $7.75 an acre or $72.25 per ton. The low productive soil gave a return of $5.75 an acre or $52.00 per ton. On the sandy land, in the residue system, rock phosphate failed to show a significant return in increased crop yields.

Potash in the crop residue system, residues, limestone, rock phosphate, potash, has given results which might appear a bit fantastic. However some of these soils are very deficient in potassium, and successful cropping is almost impossible without its use as a fertilizer. On the high productive soils, potash applications failed to give a significant increase in crop yields. On the medium productive soils muriate of potash returned $7.15 per acre each year or $143.00 per ton of material used. On the low productive soils which are extremely low in available potash, the acre return was $17.00 with $339.15 as the ton value. The sandy land, also badly in need of potash, gave a return of $14.00 an acre annually or $281.50 per ton of muriate used.

Crop residues alone on the high productive soils gave a return of $7.50 an acre annually. On the medium productive soils the increase for residue was $2.50 per acre. On the low productive soils the residues had a value of $2.75 an acre, and on the sandy land the residue returned less than $1.00 per acre. Some of the low values were due to the failure of legumes to flourish without limestone, phosphate, or potash. Generally the residues consisted of stalks, straw, soybean chaff, and other legumes where soil conditions were favorable for their growth.

All of the 21 fields had a 4-year rotation with the exception of the Joliet field which had a 6-year rotation. In central and northern Illinois the rotation was generally made up of corn, corn, oats, legume-grass. In southern Illinois where oats are usually unprofitable the rotations were corn, soybeans, wheat, legume-grass. In extreme southern Illinois where winter oats could be used, the rotations were corn, oats, wheat, legume-grass. There were in some cases slight variations from the above rotations, but in the main the income crops were corn, oats, wheat, soybeans, and hay.

The Production of Sugar Beets . . .

(*From page* 10)

Fertilizer Placement

Fertilizer rate and placement studies were conducted from 1950 to 1952 comparing 250, 500, and 750 pounds of 0-10-30. Placements included are shown in Table IV.

TABLE IV.—EFFECT OF FERTILIZER PLACEMENT ON YIELD OF SUGAR BEETS. MUCK EXPERIMENTAL FARM, 1950-52*

Lbs. per acre 0–10–30	Fertilizer placement	3-year average yields Tons/A.
750	2″ below seed	17.2
750	1″ side, 2″ below	16.9
750	Drilled, 3.5″	15.3
500	2″ below	16.0
500	1″ side, 2″ below	16.6
500	Drilled, 3.5″	14.8
250	2″ below	14.9
250	1″ side, 2″ below	14.4

* Cooperative experiment with G. A. Cummings and staff, U. S. D. A., and C. M. Hansen, Agricultural Engineering Department, Michigan State College.

These experiments were started on a fairly fertile area which had received 1,000 pounds fertilizer annually for several years. The 1950 differences due to rate or placement were very small. Similar applications on the same plots in successive years gave definite evidence of the efficiency of row applications. (See Fig. 2.) Fertilizers applied by the grain drill were less effective than either row placement. The 3-year average top yields came from 750 pounds 0-10-30 in a band beneath the seed.

General observations indicate that fertilizers placed safely close to the row lessen damage from "black root" infections of both sugar beets and table beets.

Tissue Tests

Definite potash hunger signs were noted below about 1,800 p.p.m. of K in the leaf petioles during these trials. Moderate symptoms usually are found on the plots with only 50 lbs. K_2O annually. Slight symptoms are seen at times on a plot with 100 lbs. K_2O and 200 lbs. P_2O_5.

Some Need Lime

Sugar beets will grow on soils with a wide range of pH or soil acidity. If the subsoil is extremely acid (pH 4.8 or below), the beets may become very sprangling when they reach the acid layer. Soil tests for pH should be made on the plowed layer and also at a 24-inch depth. When the pH is below 4.8, an application of 2 to 6 tons of limestone, depending upon the acidity, is advisable. The only practical method of getting lime into acid subsoils is to spread one half of the lime on the surface, plow 12 to 15 inches deep, then apply the other half after plowing and disc into the soil.

Nitrogen

Many organic soils have a total content of 3 per cent nitrogen. However, under conditions of poor to fair drainage, crops may respond to nitrogen applications. Under such conditions 20 to 40 pounds of nitrogen per acre may be beneficial to the sugar beet crop.

Boron

Boron deficiency is more likely to occur on alkaline soils, although it may occur on one which is acid. Borax should be added to sugar beet fertilizers so as to supply 40 pounds borax per acre on alkaline soils, and 15 to 20 pounds borax on acid soils.

Copper

Copper may be needed on acid soils, of pH 6.5 or below. The more acid the muck, the more chance there is of obtaining a response to copper. For newly developed organic soils, add 50

pounds copper sulfate, or its equivalent in copper oxide, as an initial application. Then apply up to 25 pounds copper sulfate equivalent annually until a total of 100 pounds copper sulfate (25 lbs. actual copper) per acre has been reached. Probably no additional copper will be required.

Manganese

Manganese deficiency symptoms, a yellowing between the leaf veins, may appear on sugar beets. However, manganese sulfate in fertilizers or in sprays has not generally increased yields of beets even where the leaf symptoms were corrected by manganese applications. Fifty to 100 pounds of manganese sulfate in sugar beet fertilizers, on soils with pH 6.5 or above, may be justified on the basis of symptoms control and possible benefits, because of the relatively low cost, equal to about .1 ton of beets.

Salt

Two hundred and fifty to 500 pounds of salt broadcast in addition to fertilizers may give a response on sugar beets, especially where available potassium is low and where low to medium amounts of potassium in fertilizers are to be applied. Responses to salt have not been consistent, according to reports from growers, and in our own experiments. Data reported by Harmer (4) from the old experimental farm, 1932 to 1941, indicated a boost of 3.9 tons of beets from 500 pounds salt in addition to 600 to 900 pounds 0-8-24 fertilizer. But on the present experimental farm, started on newly broken muck in 1941, further experiments with salt in 1942 and 1947-50 have shown increases of only about 1 to 1.8 tons sugar beets from salt in addition to 1,000 pounds 0-10-30 fertilizer. No yield increases from salt were obtained where the potash application was doubled. Further research regarding effects of sodium chloride is now in progress.

Recommendations Summary

On well-drained organic soils testing low to medium in potassium, apply 500 to 700 pounds 0-10-30 per acre for sugar beets. Where the soil test for potassium is high, apply the 0-10-20 grade. With only fair drainage, a 3-9-27 or 5-10-20 fertilizer should be used. Boron, copper, and perhaps manganese may be needed in fertilizers, as indicated above.

For most effective benefits, apply fertilizer in a band at planting, either 2 inches below or 1 inch to the side and 2 inches below the seed.

Literature Citations

1. Bigger, T. C., Davis, J. F., and Lawton, K. 1953. The behavior of applied phosphorus and potassium in organic soils as indicated by soil test and the relationship between soil tests, green-tissue tests, and crop yields. Proc. Soil Sci. Soc. Amer. 17: 279-283.

2. Davis, J. F. 1950. Soil management practices for sugar beets grown on organic soils. Proc. Amer. Soc. Sugar Beet Tech. pp. 294-301.

3. . 1951. The effect of seed source and spacing of plants in the row on the yield of sugar beets grown on muck soils. Proc. 6th Reg. Meet. Amer. Soc. Sugar Beet Tech. Eat, U.S., and Canada. pp. 117-124.

4. Harmer, P. M. 1943. Salt with potash for some crops. Better Crops With Plant Food. Reprint DD-6-43.

5. . 1943. Muck soil management for sugar beet production. Mich. Agr. Expt. Sta. Cir. Bul. 187.

6. Timm, H. 1952. The effect of potassium and sodium on the yield and chemical composition of sugar beets grown on four organic soils. M. S. Thesis, Michigan State College.

Azalea Fertilization

(*From page* 24)

soil. With these tests, the rate of fertilization was 2,000 pounds per acre of a 6-10-8 per year.

The best treatment was the use of 6,000 pounds of a 6-10-4 per acre per year, although other rates and analyses were quite good. Azaleas required a high level of fertilization for maximum

growth. And they were able, in some cases, to withstand extremely high levels of fertilizer, although the growth was not superior to lower rates. Many plants grew when as high as 10,000 pounds of a 6-10-8 per acre were applied. However, any amount over 6,000 pounds per acre was not advisable, due to the danger of killing the plants, and the additional growth (slight in most cases) did not warrant the additional fertilizer costs.

Additions of minor elements to the fertilizers did not, in most cases, prove beneficial. Results secured were so erratic that no recommendations can be made. The inclusion of the minor elements was not harmful but, at the same time, did not appear to be particularly beneficial. A sufficient supply of the minor elements was available—either added as impurities in the commercial fertilizers used or was present in the peat and sand. Thus, they were released rapidly enough to meet all requirements.

The use of sawdust or peanut hulls as the source of organic matter was detrimental at the level of fertilization used (2,000 pounds of 6-10-8 per acre). In using these materials, much higher rates of fertilization would be necessary.

Increased growth did not warrant the use of over 25% peat in the soil, according to the results. In addition, the source of peat (domestic or foreign) made no difference. The data cannot be applied indiscriminately to all soils, however, because the type and reaction of the soil determine to some extent how much acid peat should be used. In many areas, the recommendation that azaleas be grown only in peat without the use of soil exists today. The soils in those areas are alkaline.

A Bear-killer's Politics

(*From page* 5)

powder, and that's what I went for."

In his second bid for the legislature in 1823, Davy had as an opponent a Doctor Butler who was a nephew of General Jackson, and as Crockett said, "the most talented man I ever run against for office." The method of electioneering favored by Crockett is best told in his own words:

"I decided to go prepared to put every man on a good footing when I left him. I had a large buckskin hunting shirt made, with a couple of pockets holding about a peck each; and in one I carried a big twist of tobacco and in the other a bottle of my liquor; for I knowed when I met a man and offered him a dram, he would throw out his cud to take his horn. After he had his swig I would out with my twist and give him a fresh chaw. Then he would not be any worse off than when I found him and I would leave him in a good humor."

But two other candidates broke into the fracas nevertheless, yet Crockett was determined to "stand up to my lick-log." They all ran the race through and it turned out that Davy beat them all by a majority of 247 votes—being again returned to the legislature on his popularity as the bear-hunter from the canebrakes.

In 1824 the settlers prevailed on Davy to run for Congress against a formidable opponent—Colonel Alexander, then the representative at Washington, whose votes on the tariff did not please some of the backwoodsmen. "But this time Providence was against me," resumes Crockett. "It was the year that cotton brought $24 a hundred and so Colonel Alexander could get up and tell them that his tariff law had raised the cotton price. So I might as well have sung psalms over a dead horse as to try to make them believe anything else, and they thought that if the Colonel hadn't raised their cotton price, they didn't know what had. He made a mash of me this time, although he only beat me by two votes—and yet

I got my chance the next time. After he served out that term, cotton was down to $8 a hundred and I decided to try him again."

Between the two campaigns Crockett engaged in a boat freight venture that proved disastrous, after some exciting adventures on the Mississippi and at Memphis and Natchez. So when he began his second fight against Colonel Alexander he financed himself on borrowed funds.

"Nobody ever did know how I got money to get along on till after the election was over and I had beat my competitor 2704 votes. Even the price of cotton couldn't save my friend Aleck this time. My rich friend who had been so good to me, now sent for me and loaned me a hundred dollars and told me that sum would bear my expenses down to Congress, but after that I must shift for myself. I came to Washington and drawed $250 and purchased with it a check on the Nashville bank and enclosed it to my friend—nobody living loves a friend better or remembers a kindness longer."

AN amusing incident occurred as told by Davy relating to a sort of early type of Lincoln-Douglas debate that he and Aleck held in their campaign. During the speech by the Colonel in which he never mentioned Crockett in any manner and rather disdained to, a flock of guinea hens came by the spot and set up a loud chattering. They confused the speaker and he stopped and asked that they be shooed away.

"I let him finish and then I spoke and told him that he had forgot his politeness by not naming me in his talk. I said that when my little friends, the guinea hens, came up and began to holler out 'Crockett, Crockett' he had been ungenerous enough to stop and ask that they be driven off. This raised a loud shout and the Colonel seemed mighty bad plagued. But he got more plagued than this at the polls."

Mr. Adams was president during Davy's first congressional term. In 1829 Crockett was re-elected by a heavy majority. But then Davy decided he couldn't stomach all of the policies of Gen. Jackson. He felt that he had been named by a majority of 3,587 votes and that the people did not want him to vote for any unjust motion to please Jackson. It was then considered an unpardonable sin to turn against Old Hickory.

Crockett explains at this moment in his career in public office he was outsmarted by the "little four-pence-ha' penny limbs of the law" who hit on a plan to beat him by mean strategy. They all agreed to distribute written and verbal notices of Davy's appearance at any given place of assembly without his knowing when and where—so he was usually absent. Thereupon these fellows were there with their saddlebags full of Jackson newspapers, and they got up and spoke in strong terms about Davy's Washington attitudes against Old Hickory's bank moves and other matters not to Davy's liking. They would say that Davy was afraid to come after all and it was the duty of the electorate to reject him. This was the campaign of 1831—where Davy won majorities in 17 counties but was defeated by the votes in the 18th —Madison county.

However, in the next—and last—election that Crockett took part in as a candidate, he won handily over Mr. Fitzgerald and took his seat in Congress again in 1834. It was right after this in April of that year when Davy took his exciting pilgrimage through the Northeastern states—receiving huzzas and receptions and many presents (including a new rifle) from the citizens of the effete East, who were anxious to see this wild man from the canebrakes. In fact, his memoirs are not too much exaggerated in stating that his name was as well known in public life as those of Webster and Clay. Instead of seeing a rough, uncouth, and awkward figure, the residents of New York and Boston welcomed a lithe, sharp-witted, and

amiable man, whose language and deportment—as well as fondness for frequent "nips"—put him among the leaders of his era. With less than six months' formal schooling, this rugged individualist showed remarkable improvement in vocabulary and choice of expression. Not a few supporters of his linked his name with the presidency, and had he not chosen to aid Texas against Santa Anna (or had he escaped the fate that awaited him in the Alamo) it is likely that his name would have been seriously considered.

WE still have space to recount a couple more of the sketches which Davy gave to posterity as reflections of the manners and customs which animated the frontier during critical elections. Contrasting their times with ours, we come out sometimes on the hind side insofar as public zeal and interest in government are concerned. We may have stopped some of the free-flowing nectar of Zea maize and the fisticuffs that marked the old decisions of democracy, but we have lost things a "darn sight wuss."

Now to resume with another anecdote by Crockett, taken from "Pictorial Life and Adventures of Davy Crockett, Written by Himself," published first in 1834 and reissued in 1866 by T. B. Peterson & Bros., Philadelphia, publishers of Peterson's Magazine.

"I started off to the Cross Roads, dressed in my hunting shirt and with my rifle on my shoulder. Many of our constituents had assembled there to get a taste of the quality of the candidates at orating. Job Snelling, a gander-shanked Yankee, who had been shipped to the West with a cargo of codfish and rum, erected a big shanty and set up shop for the occasion. I soon mounted a stump and began bushwhacking in most approved style. Soon I heard an uproar from the crowd that they could not listen to me on such a dry subject as the national welfare until they had something to drink

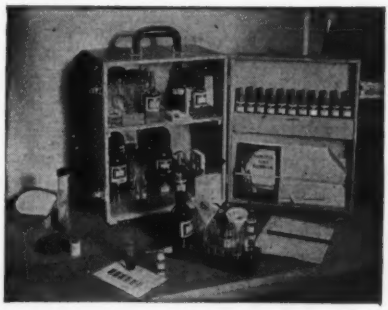
Time Proven LaMotte Soil Testing Apparatus

LaMotte Soil Testing Service is the direct result of 30 years of extensive cooperative research with agronomists and expert soil technologists to provide simplified soil testing methods. These methods are based on fundamentally sound chemical reactions adapted to the study of soils, and have proved to be invaluable aids in diagnosing deficiencies in plant food constituents. These methods are flexible and are capable of application to all types of soil with proper interpretation to compensate for any special soil conditions encountered.

Methods for the following are available in single units or in combination sets:

Ammonia Nitrogen	Iron
Nitrate Nitrogen	pH (acidity & alkalinity)
Nitrite Nitrogen	
Available Potash	Manganese
Available Phosphorus	Magnesium
Chlorides	Aluminum
Sulfates	Replaceable Calcium

Tests for Organic Matter and Nutrient Solutions (hydroculture) furnished only as separate units.



LaMotte Combination Soil Testing Outfit

Standard model for pH, Nitrate, Phosphorus and Potash. Complete with instructions.

Illustrated literature will be sent upon request without obligation.

LaMotte Chemical Products Co.

Dept. BC Towson 4, Md.

—and would I stand treats? They went with me to the shanty shouting 'Huzza for Crockett!'

"I called for a whole quart of the best, but the crooked critter pointed at a sign over the bar in big letters, 'Pay Today and Trust Tomorrow.' Ready money in the West in those times was shy and it was most particular shy with me then. Seeing my predicament, the voters fell off to the other side and I was left deserted like the government with no offices to bestow."

Anyhow, Crockett says he struck off into the woods at once with his rifle and inside of half an hour he treed and shot a coon. He whipped out his knife and skinned the coon and took the hide back to Snelling's shanty. He walked up to the bar, but not alone, as he had several of his constituents marching behind him that way.

"I threw down the coon skin on the counter and called for a quart, and Job knew well that a coon skin was legal tender for a quart, as good as a New York shilling any day. My constituents crowded around the bar with shouts of 'Crockett Forever.' Having soon dispatched the value of my coon hide, I went out and mounted the stump. Before I was through one of them moved they would hear the balance of my speech after they had washed down the first part with some more of Snelling's extract of cornstalks and molasses; and the question being put, it was carried unanimously—and I began to reckon that the fate of the nation depended on my killing another coon.

"While standing at the bar feeling sort of bashful with Job's rules staring me in the face, I cast down my eyes and discovered one end of the old coon skin sticking between the logs supporting the bar. I gave it a short jerk and it followed my hand natural as could be as if I was the owner. I slapped it on the counter, and Job, little dreaming he was barking up the wrong tree, shoved me another bottle—soon dispatched in good humor, as some of the voters saw my trick.

"Soon the voters got dry again near the rostrum and nothing would do but we must adjourn to the shanty, where as luck would have it, the same old coon skin was still sticking out between the logs. More rum followed after the same fashion, and I wish I may be shot if I didn't before the day was over get 10 quarts for the same identical coon skin and from a fellow who was as sharp as a steel trap and bright as a pewter button. The joke secured my election as it circulated like smoke among my constituents and they allowed that the man who could get the whip hand of Job Snelling in fair trade could outwit Old Nick himself and was the real grit for them in Congress. But after the election I sent Snelling the price of the rum. Job refused the money and sent me word that it did him good to be taken in occasionally as it served to brighten his ideas. I found out afterwards that he really put the price of the rum into the bill of my opponent, who did not examine the particulars of a small vender of rum and paid it."

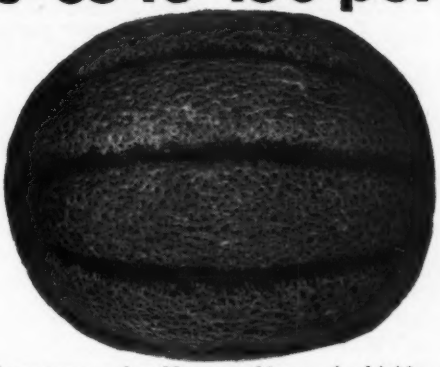
AFTER that delightful bit of rare old Americana, we may close in reverence with the last words from the diary of Davy Crockett, written after all hopes of getting help from Goliad or Refugio was abandoned by Travis and the volunteers within the Alamo.

"March 5, 1836—Pop, pop pop! Bom, bom, bom! All throughout this day —no time for memorandums now—Go ahead! Liberty and Independence forever!"

No wonder that my relatives of the older generation told me that Crockett was one of their heroes—even up in the woods of the Lake states. He may have been rude and bold in speech, but he had within him the same spirit of liberty and truth that has since made heroes of schoolboys in our battles of several wars.

NEWS FROM NAUGATUCK

ALANAP®-1 Weed Killer saves $35 to $150 per acre



Extensive field use proves that Naugatuck's new herbicide, Alanap-1, can save growers of cucumbers, melons and squash countless dollars by practically eliminating hand weeding.

One experiment revealed that cucurbit yields were actually doubled by a pre-emergence application of Alanap-1. "Plants in untreated rows were severely stunted by weed competition before the fields could be cultivated and hoed, whereas treated rows were still not suffering... two months after planting."

As a pre- or post-emergence weed killer, Alanap-1 gives excellent control of a variety of annual weeds, is non-hazardous to humans, animals, easy to apply, low in cost, and safe on recommended crops which now include asparagus.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

producers of seed protectants, fungicides, miticides, insecticides, growth retardants, herbicides: Spergon, Phygon, Aramite, Synklor, MH, Alanap, Duraset.

US RUBBER

LET NAUGATUCK HELP SOLVE YOUR PROBLEM—
FILL IN COUPON FOR FAST ACTION—EXPERT ADVICE

WHAT CROP?_____

Weeds to control?_____

Acreage_____

NAME_____

ADDRESS_____ CITY_____ STATE_____

FREE LOAN OF EDUCATIONAL FILMS

The American Potash Institute will be pleased to loan to educational organizations, agricultural advisory groups, responsible farm associations, and members of the fertilizer trade the motion pictures listed below. This service is free except for shipping charges.

FILMS (ALL 16 MM. AND IN COLOR)

The Plant Speaks Thru Deficiency Symptoms (Sound, running time 25 min. on 800-ft. reel.)

The Plant Speaks, Soil Tests Tell Us Why (Sound, running time 10 min. on 400-ft. reel.)

The Plant Speaks Thru Tissue Tests (Sound, running time 14 min. on 400-ft. reel.)

The Plant Speaks Thru Leaf Analysis (Sound, running time 18 min. on 800-ft. reel.)

Save That Soil (Sound, running time 28 min. on 1200-ft. reel.)

Borax From Desert to Farm (Sound, running time 25 min. on 1200-ft. reel.)

Potash Production in America (Sound, running time 25 min. on 800-ft. reel.)

In the Clover (Sound, running time 25 min. on 800-ft. reel.)

In Canada: The Plant Speaks Thru Deficiency Symptoms
The Plant Speaks, Soil Tests Tell Us Why
The Plant Speaks Thru Tissue Tests
The Plant Speaks Thru Leaf Analysis
Borax From Desert to Farm
Potash Production in America

DISTRIBUTORS

Northeast: Educational Film Library, Syracuse University, Syracuse 10, N. Y.

Southeast: Vocational Film Library, Department of Agricultural Education, North Carolina State College, Raleigh, North Carolina.

Lower Mississippi Valley and Southwest: Bureau of Film Service, Department of Educational Extension, Oklahoma A & M College, Stillwater, Oklahoma.

Midwest: Visual Aid Service, University Extension, University of Illinois, Champaign, Illinois.

West: Department of Visual Education, University of California, Berkeley 4, California.
Department of Visual Education, University of California Extension, 405 Hilgard Ave., Los Angeles 24, California.
Department of Visual Instruction, Oregon State College, Corvallis, Oregon.
Bureau of Visual Teaching, State College of Washington, Pullman, Washington.

Canada: National Film Board, Ottawa, Ontario.

For the Province of Ontario: Distribution Services, Ontario Agricultural College, Guelph, Ontario.

IMPORTANT

Requests should be made well in advance and should include information as to group before which the film is to be shown, date of exhibition (alternative dates if possible), and period of loan.

Request bookings from your nearest distributor.

AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

Reprints

28-12-45 Better Corn (Midwest) (Circular)
F-3-40 When Fertilizing, Consider Plant-food Content of Crops
S-5-40 What is the Matter with Your Soil?
Y-5-43 Value & Limitations of Methods of Diagnosing Plant Nutrient Needs
A-1-44 What's in That Fertilizer Bag?
P-3-45 Balanced Fertility in the Orchard
Z-5-45 Alfalfa—The Aristocrat
OO-8-45 Potash Fertilizers Are Needed on Many Midwestern Farms
ZZ-11-45 First Things First in Soil Fertility
T-4-46 Potash Losses on the Dairy Farm
Y-5-46 Learn Hunger Signs of Crops
T-4-47 Fertilizer Practices for Profitable Tobacco
TT-11-47 How Different Plant Nutrients Influence Plant Growth
VV-11-47 Are You Pasture Conscious?
R-4-48 Needs of the Corn Crop
X-6-48 Applying Fertilizers in Solution
AA-6-48 The Chemical Composition of Agricultural Potash Salts
GG-10-48 Starved Plants Show Their Hunger
SS-12-49 Fertilizing Vegetable Crops
BB-8-50 Trends in Soil Management of Peach Orchards
X-8-51 Orchard Fertilization Ground and Foliage
BB-10-51 Healthy Plants Must Be Well Nourished
II-12-51 Pasture Improvement With 10-10-10 Fertilizer
KK-12-51 Potassium in Animal Nutrition
A-1-52 Research Points the Way to Higher Levels of Peanut Production
O-4-52 Tomato Production for the Canning Industry
Y-10-52 The Nutrition of Muck Crops
CC-12-52 The Leaf Analysis Approach to Crop Nutrition
I-2-53 Sericea Is a Good Drought Crop
J-3-53 Balanced Nutrition Improves Winter Wheat Root Survival
K-3-53 Kudzu Keeps Growing During Droughts
N-4-53 Coastal Bermuda—A Triple-threat Grass on the Cattleman's Team
P-4-53 Learning How to Make Profits from Sweet Potatoes
S-5-53 More Cotton on Less Land
T-5-53 Trefoil Is Different
W-6-53 The Development of the American Potash Industry
DD-10-53 Sampling Soils for Chemical Tests
FF-10-53 Testing and Reclaiming Alkali Soils
II-11-53 The Importance of Legumes in Dairy Pastures
JJ-11-53 Boron—Important to Crops
MM-12-53 White Birch Helps Restore Potash-Deficient Forest Soils
D-1-54 Relation of Potash and Phosphate to Cold Injury of Moore Pecans
K-2-54 Soil and Plant Analyses Increase Fertilizer Efficiency
R-3-54 Soil Fertility (Basis for High Crop Production)
U-4-54 Nutrient Balance Affects Corn Yield and Stalk Strength
BB-6-54 Potash Pays on Forage in New England
CC-6-54 Fertility Increases Efficiency of Soil Moisture
DD-6-54 Surveying California Citrus with Leaf Analysis
EE-8-54 Red Apples Require Balanced Nutrition
FF-8-54 Apply Fertilizers in Fall For Old Alfalfa, Grass Pasture and Timothy-Brome Fields
GG-8-54 Effect of Boron on Beets and Crops Which Follow
JJ-10-54 Principles Involved in Soil Testing
LL-10-54 Relation of Fertilizer to Quality and Yield of Flue-cured Tobacco
MM-10-54 Longer Life for Ladino
SS-11-54 Foliar Application of Plant Nutrients to Vegetable Crops
TT-11-54 Leaf Rust Reaction in Relation to Wheat Fertilization in Indiana
UU-12-54 Alfalfa in Mixtures for Pasture, Silage, and Hay
VV-12-54 Potassium Affects Growth of Stocks
YY-12-54 Physical Condition of the Soil Affects Fertilizer Utilization
ZZ-12-54 Economical Use of Fertilizer in North Carolina
A-1-55 Potash-Deficiency Symptoms
B-1-55 The Net Worth of Soils in the Northeast
C-1-55 Summary of Ten Years' Work with Complete Fertilizers on Sugar Cane
D-1-55 Nitrogen Use Accentuates Need for Minerals
E-1-55 Guides to the Management of Illinois Soils
F-1-55 The Soil Profile's Contribution to Plant Growth
G-2-55 Seven Steps to Good Cotton
H-2-55 Apparent Fertility Trends in Western Irrigated Soils
I-2-55 Shortages of Potash Limit Grape Yields
J-2-55 Fruit Fertilization in New Jersey
K-2-55 South Carolina's Peach Industry Adopts New Ideas
L-3-55 Soybean Production in the Southern States
M-3-55 Possibilities and Limitations of Irrigation in the Southeast
N-3-55 The Pacemaker Club Grows More Corn
O-3-55 Using Soil Tests to Predict a Probable Response from Fertilizer Application
P-3-55 N-P-K for Deciduous Fruit Trees
Q-3-55 Soil Testing Moves Ahead in Arkansas

THE AMERICAN POTASH INSTITUTE

1102 16th STREET, N. W. **WASHINGTON 6, D. C.**

A girl from Texas was being prepared for a trip to New York by her mother. Together they had shopped and bought clothes for every possible contingency. New luggage was procured and finally the girl was ready to leave for the station. As she was about to kiss her mother farewell, the mother said:

"Now, dear, don't you mention to the folks in New York that you're from Texas. That would be like talking about money in front of poor people. We mustn't parade our advantages."

* * *

Helen (in movies): "Doesn't the hero ride beautifully? Just as though he were part of the horse."

Gerald: "Which part?"

* * *

It was rugged mountain country, and very large families were the custom. One day two old fellows met at the country store, and one said: "You chance to be a relative of Eph Hornbuckle over on Redbird Creek?"

"I been told we're distant kin," was the reply. "I'm the oldest young'un, Eph's the seventeenth."

* * *

At a popular port all the crew asked for shore leave except one man.

"What's the matter?" asked the officer. "Are you the only sailor that hasn't got a wife in this port?"

"No. I'm the only one that has!"

Tramp: "I ain't got a friend nor a relative in the world, mum."

Housewife: "Well, I'm glad there's nobody to worry over you in case you get hurt. Here, Tige—sic him!"

* * *

Two inveterate golf bugs had just landed on the 12th green of their club course when a funeral procession slowly wound its way past them on the adjoining highway.

One of the golfers respectfully doffed his cap and bowed his head low until the cortege disappeared.

"That was a nice gesture, George," said the other golfer. "I had no idea you were so sentimental."

George picked up his putter and carefully measured the distance to the hole.

"Well, it was the least I could do," he said. "Two more days and we would have been married 25 years."

* * *

Pappy: "You been seein' Nellie nigh on to a year. What are your intentions?"

Hillbilly: "You mean I got a choice?"

* * *

"Eph, did yo' all know dat Jonah done spent three days in de stomach ob a whale?"

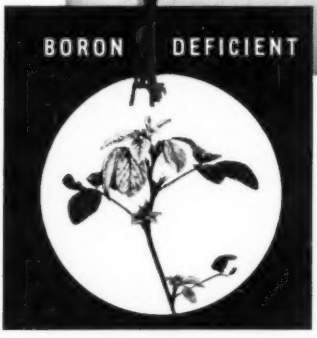
"Humph! Dat ain't much. Mah uncle wuz longer dan dat in de stomach of a alligator."

"Sho nuff! How long?"

"He dar yit."

Here's PROOF... $1 to $2 spent on

Fertilizer Borate (HIGH GRADE)



can give you an extra ton of Alfalfa hay per acre...

See for yourself what Fertilizer Borate, with its high boron content, meant to this alfalfa field. Boron, so vital to alfalfa, is also required by other field crops such as clover, sweet corn, tobacco... and most vegetable and fruit crops. This year, invest a few extra pennies per acre in Fertilizer Borate... the low-cost fertilizer grade of borax... to grow better crops!

. . . . Look for These Symptoms in Alfalfa: Lack of boron causes plants to become puny and dwarfed. Look for yellow or reddened top leaves, stunted, with growing tips rosetted. See close-up photo.

● *Fertilizer Manufacturers* — ***Here's Borax at the Lowest Cost per Unit... It's Fertilizer Borate-High Grade!***

This sodium borate concentrate, developed especially for the fertilizer trade, has higher analysis... approximately 121% borax equivalent. Choice of fine or coarse mesh.

Write for Bulletin PF-3!

PACIFIC COAST BORAX CO.

DIVISION OF BORAX CONSOLIDATED, LIMITED

630 SHATTO PLACE, LOS ANGELES 5, CALIF. • 100 PARK AVE., NEW YORK CITY 17

MANUFACTURERS OF FAMOUS "20 MULE TEAM" PACKAGE PRODUCTS

AUBURN, ALABAMA • 1st National Bank Bldg.
CALGARY, ALTA., CANADA • 2031 40th Ave., S.W.
POCATELLO, IDAHO • P.O. Box 1491
COLUMBIA, MISSOURI • P.O. Box 236
PORTLAND, OREGON • 1504 N.W. Johnson Street
KNOXVILLE, TENN. • 6105 Kaywood Drive
HOUSTON, TEXAS • 1503 Hadley Street
MADISON, WISCONSIN • 1805 Capital Ave.

Better Crops
with PLANT FOOD

IF NOT DELIVERED, return to
AMERICAN POTASH INSTITUTE, INC.
1102—16th St., N. W., Washington 6, D. C.
RETURN POSTAGE GUARANTEED

Sec. 34.66, P. L. & R.
U. S. POSTAGE
PAID
Washington, D. C.
Permit No. 2283